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Philadelphia's Subway Begun

THE city of Philadelphia, Mayor Blankenburg and A. M. Taylor, director of city transit, are to be congratulated on the opening of construction work on the first section of new subway, noted elsewhere in this issue. The work done by Mr. Taylor on this project is of a sort too rarely found and sorely needed from the engineer. Not only has a modern high-speed transit system, which is the last word in economic city transit development for the third city of the continent, been planned under his direction, but he has shown the ability and the courage to use proper publicity methods in educating the population of that city to see what is needed, and how it is to be secured. The result is a large public engineering project that seems happily destined to be carried to a logical and scientifically proper conclusion by the active help of the public. That this success had been solidly achieved was told the country in unmistakable terms last April, when the citizens of Philadelphia voted the money to begin the new project by a ten-to-one majority. In sad contrast to this admirable achievement stands the long wrangle over the completion of the St. Louis Free Bridge, only recently ended, and the political troubles of many another public engineering project. Mr. Taylor took the daily press into his confidence. He and his colleagues have improved every opportunity to speak at public gatherings. The need for the project, and the great benefit the public will derive from it have been driven home till everyone in that great city is familiar with it, and practically every one is actively in favor of it. Mr. Taylor's methods command the close attention of every engineer who has charge of public improvements. They point the way to better public understanding of the engineer and his work, and to the general clearing up of many difficulties that have arisen from misunderstanding in the past.

Road Building Economics

THE GOSPEL of good roads has been so generally preached throughout the country that it is now much easier than formerly to convince people of the economy of building good roads. Even in rough and mountainous regions where the first cost of a road of any kind is high, steep and narrow highways are being avoided, and in fact extremely heavy grading is done to secure good alignment with easy grades. Expensive brick and concrete pavements have appeared where any sort of a crooked road was considered good enough a few years ago. In recent years California has taken the lead in not a few phases of road construction, and it is not surprising to

find the Highway Commission of that State adopting such a policy as that indicated by Commissioner Darlington in his article on the "Ridge Route," on page 322 of last week's issue. The 115-mile stretch Mr. Darlington refers to runs through territory that is not expected to be productive of tributary traffic at all commensurate with the cost of the road. It has been built, rather, for the sole purpose of shortening the distance between two important centers in southern California. This means that the expenditure is to be considered an investment, without guarantee of returns other than the confidence which the Highway Commission has in the future of the two centers connected by the road and the extent to which such connection will encourage and increase traffic between them. Road building on this basis is comparable to railroad construction, where an unproductive and highly expensive stretch must be built in order to complete the system between important terminals. Such projects require faith in the section of the country being developed. They require backing by vigorous and imaginative minds, and it is only men of broad gauge who dare undertake them.

Condition of Aqueduct Bronze

FROM stories published in some of the New York papers early this week it would have appeared that the nearly completed Catskill aqueduct for the city's additional water supply was about to end in a "fiasco." The accounts were colored with exaggerated statements concerning the failure of the bronze (more correctly brass) fittings in the deep pressure tunnels. On a work of this magnitude it is not to be expected that every detail, especially where there is little or no precedent to serve as a guide, will be perfected at the first trial. There has been trouble with the so-called bronze parts, as described in this journal by Alfred D. Flinn, deputy chief engineer of the Water Board and Ernest F. Jonson, engineer of tests, but the difficulty will not retard the delivery of Catskill water beyond the time estimated, the fall of 1916. Mr. Flinn was asked to make a brief statement giving the facts in the case and his reply follows: For certain bolts, ladders, pipe fittings, valves and similar parts which would be exposed to moisture and difficult of replacement, the engineers of the Board of Water Supply sought a material highly resistant to corrosion and of sufficient strength to replace cast iron and steel, commonly used for such purposes. After careful inquiry, manganese bronze, Tobin bronze and naval brass were adopted. In the course of time some bolts were found cracked, and, as time progressed, this trouble with rolled and drawn material

proved to be so extensive as to necessitate replacement in a great many instances. The large forgings, principally for valve and sluice gate stems, have developed no defects. Most of the castings have continued to be sound. Recently, however, a number of castings, especially parts of large bronze gate valves, have developed fine cracks. Apparently, these cracks result from repairs of foundry defects made by the process of "burning in" or welding, which has long been practised in most, if not all, brass foundries. These valves are in chambers near the surface of the ground where they are accessible for removal, for replacement or such repairs as may be decided upon. The trouble mentioned is annoying but will not delay the introduction of Catskill water beyond the time expected, the fall of 1916. The expense will be but a small part of the figures stated by some of the daily papers.

Road Legislation and Finance

IF the cause of good roads is not to be checked in the remarkable progress it has made during the last few years, immediate action must be taken to correct two fundamental difficulties of the complex problem. In the mad rush of planning State-wide highway systems and placing work under contract the basic questions of legislation and of finance have been sadly neglected. It is time to start unsnarling a tangle which is complex enough now, but which will be drawn tighter and tighter as time goes on. As a basis for beginning this work, two papers presented at the Pan-American Road Congress this week and printed on pages 351 and 352, contain valuable suggestions. One, by A. N. Johnson of the New York Bureau of Municipal Research, outlines the essentials of proper highway laws and the other, by Nelson P. Lewis, chief engineer of the New York Board of Estimate and Apportionment, discusses the fallacy of long-term bonds for short-lived highway structures. Piecemeal legislation, amendment piled on amendment, special enactment and repeal—all have combined to make the field of highway legislation a maze in which even the experienced seeker for facts soon loses his way. It is time for a general revision of State highway laws and a rearrangement of organization on a simple logical basis which will centralize authority in a non-partisan State department of technically qualified officials, assured of retention in office so long as their work is well done. In fact, if the proper power were vested in the State highway department much of the present confusing legislative enactment could be dispensed with and covered simply by department rules and regulations. The alarming financial situations which have been

created in some States by the issuance of 50-year bonds for road surfaces which cease to exist after 10 years, cannot be condemned too strongly. Mr. Lewis gives some sound advice on the general subject of road financing and dwells particularly on the merits of the short-term and serial bond. The two papers are very closely inter-related and highway engineers, when they return home from the Coast, will do well to see that the members of their State Legislatures are acquainted with the unsatisfactory condition of affairs and its remedy.

How Will Chicago Utilize Its Traffic Census?

TWO legitimate causes for wear and destruction of pavements are traffic and weather. Under severe climatic conditions the latter does the most damage, but ordinarily traffic is the chief cause. Irrespective of the actual condition of a given pavement traffic records are figured as being valuable for future use in estimating first cost and maintenance cost and in selecting types of pavement. Therefore, a traffic count taken in one of the most congested districts of the second largest city in the country cannot fail to attract widespread interest. On page 364 is an article describing the methods pursued and the results obtained in making a traffic census of Chicago's Loop district. The census was taken by the Bureau of Streets to ascertain the effect of all vehicles on street cleaning and as a guide in determining the kind of pavement which should be laid on the streets under observation.

To be of any value in the selection of pavement traffic counts should be carried on over a series of years during the life of the pavement under investigation, records being taken, during the original construction, of the subsoil, drainage, kind of paving, foundation and manner in which paving is laid. In counting traffic note should be taken of the tendency of the vehicles in keeping to the roadway or to track space. In counts subsequent to the first the rate of wear should be recorded if possible and how, when and where deterioration sets in and its possible causes noted. Colonel Waring of New York City, in one of the most comprehensive reports on street cleaning ever published, reported a traffic census taken over several years in the late nineties which enabled him to determine the existing difficulties encountered for each type of pavement under every conceivable kind of traffic. He was then able to reroute his street cleaners. This is one of the prime values of a traffic census applied to street cleaning.

In any close apportionment of cleaners averages are of little value because street conditions are continually changing. Erection of a skyscraper puts a heavy load on the streets traversed by the material wagons, and the piling up of the pavement and earth on the sidewalk while a public utility lays its conduits immediately upsets former arrangements. Undoubtedly the continued tearing up of pavements for underground work in downtown Chicago

has far more to do with the deterioration of pavements than any other one factor and just how the department can be helped in the choice of pavements unless it takes into account these other factors is hard to see. The engineering public, particularly that portion interested in street work, will look with interest to see how Chicago's traffic census will be utilized.

Visual Identification of Longleaf Pine—Its Importance

PROGRESS in timber specifications, at least for the Southern yellow pine variety, which, until recently, has been the most important for engineers in the eastern half of the United States, has been very rapid in the last three years. On the parts of the producer and the consumer there has been a determination to find some method of judging the value of timber that should enable, to a great extent, the elimination of dispute, not possible when the chief item of the specification is one as to botanical species. Within the three-year period referred to the acceptance of the ring specification has been widespread, though it has been previously used with wide variations in the number of rings specified. The Forest Products Laboratory has persistently advocated the new ring specification, while its acceptance by lumber associations has given it firm standing among producers.

Now comes a new and very important development in timber identification. The method is not based on strength, and disregards botanical species entirely, as does the ring specification. It determines by easily applied means the botanical species itself. It has been repeatedly stated that, once the log has left the stump, it is impossible by any readily applied means to determine the botanical species. Identification could be made with the microscope. That was true in the prior state of the art, but has ceased to be true now, for on page 319 of last week's issue was described a visual method of distinguishing longleaf from shortleaf and loblolly pine. It depends on the diameter of the pith and of the second annual growth ring. In longleaf the pith is always 0.10 in. or more in diameter. Some shortleaf and loblolly logs, however, will have piths of 0.10 in. or more, and to insure identification measurement is taken over the second annual ring and the application of this reading and of the pith diameter to a chart determines the identification.

The method appears to be even less open to chance for disagreement than the ring specification. Obviously it is not supplemental to the latter, but stands as a separate, alternative method for purchasing. The ring specification professedly cares not for botanical species so long as the timber is one of the Southern pines. It is predicated solely upon density and strength. The theory back of the new visual test proposed by Mr. Koehler, on the other hand, is based upon confidence in the uniform excellence, as regards strength, of longleaf yellow pine, and purposes, therefore, to make its identification certain.

Obviously the method is a test only. In specifications it would have to be supported by clauses as to straightness of grain, knots, shakes, etc. These additional clauses might well be copied from the recent specifications embodying the ring method, and restricting defects in certain volumes of the stick.

From the trade standpoint the new test is of the very greatest importance. "Longleaf" is a term that carries to the engineer assurance of dependable strength, and there is little doubt that if this test had been developed three years ago it, and not the ring clause, would have become the basis of the newer specifications. It is less revolutionary than the ring clause and would have entered more naturally into the developing pine specifications. Undoubtedly the method of purchase by botanical species will continue, even though the more recent specifications abandon the method. Custom is hard to change, and now that identification of the species is easy, there will be less reason for abandoning the time-honored practice. Progressive producers who want the trade that is willing to pay well for quality will not be slow to recognize the new opportunity, and it is understood that several lumbering interests will shortly announce their readiness to ship under the pith-diameter clause.

The new test is a striking example of the excellent practical help which the Forest Products Laboratory is giving the engineering profession and the lumber industry—help that in the last analysis redounds to the benefit of the country at large.

American Society Stiffens Admission Requirements

A MORE uniform and, in general, a more exacting treatment of applicants for admission to or transfer in the American Society of Civil Engineers is the objective of five resolutions recently passed by the board of direction. The first of these states that no applicant shall be admitted to any grade whose qualifications do not clearly exceed the minimum requirements of the constitution. The second voices the desirability of more than five references whenever possible, and of furnishing the names of persons, whether members of the society or not, who have personal knowledge of the applicant's work in each position enumerated. The third calls for markedly superior qualifications for candidates, who, at the time of application, are not engaged in work demanding engineering education or training. The remaining two emphasize the difference between associate membership and membership, and advocate admission to the latter grade only through transfer from the former, "unless a candidate is eminently qualified for the highest grade."

The resolutions should meet with general approval, and the second is especially to be commended. Too many inequalities in ranking exist at present. Some men have been helped in attaining corporate membership through social acquaintance with older members, and others have been held back through lack of association with members

of the society. The demand for personal knowledge of the professional achievements of the candidate will tend to check the growth of the former class, while the recognition of the value of non-members as references will remove a handicap from the latter class. In fact, the board has heretofore accepted references from non-members in other continents, where members are scarce, but in North America it has not evinced interest in the knowledge or opinions of outsiders. It now remains for all concerned to assume a sacred responsibility for preserving the standards of the society, even against the temptations of friendship and good nature, to the end that the board of direction, whose members are not likely to know all of the many of the applicants, may make no mistakes.

Features of Mitering Lock-Gate at Keokuk

CANAL engineers will turn with interest to the article in this issue on the mitering lock-gate at Keokuk, this article being the first complete and authoritative description of this novel structure so far published. While this journal, during the period of the construction of the development, called attention to some of the unusual features of the gates, opportunity was not afforded for that close study necessary to bring out in all completeness the many departures in lock-gate construction. There is a special satisfaction in presenting the description now, since two years of operation have demonstrated the correctness and value in service of the departures embodied in the design.

To mention all of the features that deserve special consideration of hydraulic engineers would be to repeat in large part the article Mr. Parsons has written. Most notable is the character of the framing on the back of the gate, designed to resist warping stresses and to carry the dead load of the structure itself. The horizontal principle, represented in the curved ribs carrying the water pressure by arch action, is not new, but heretofore gates which have used this principle have had cylindrical surfaces both up and downstream. Such gates, however, are likely to warp, not only from their dead weight but also on account of the application of the moving stress at the top only. Débris caught between the miter posts in the lower part of the gate is also apt to give considerable trouble.

The merits of the Keokuk type of framing are apparent. If any further endorsement is needed it may be found in the fact that this type of framing has, after much investigation, been adopted for a lock on the Ohio River near Louisville, though both horizontally and vertically framed gates were considered. It might be well to note that an alternative design, a horizontally framed gate, was considered at Keokuk, but was eliminated because of the great excess in weight of the alternative and the greater difficulty in fabrication, particularly at the miter posts and quoins. In the alternative designs at Louisville the Keokuk type of gate weighed 500,000 lb. as against 750,000 lb. for the horizontally framed gate. It is

only just to remark, however, that a vertically framed gate, figured on for the same lock, weighed about the same as the Keokuk design. It has not, however, the inherent stiffness represented by the latter type.

Space does not permit detailed discussion of other features of the gate and readers will be repaid by a very careful study of the article referred to. The specifications for the steelwork, the permanent anchorage and hinge block, the seal at the miter sill, the very important advantages gained by the dead-centered position of the operating strut at both ends of travel, and the great care taken to secure tightness are all features that might be enlarged on at length. Suffice it to say that the departures made in the design have been more than justified by the service which the gate has been giving. The adoption of the most important of the departures, the back framing of the gate, by the Corps of Engineers is sufficient endorsement of the excellence of the Keokuk accomplishments.

A Report Humanized

A REMARKABLE document was published this week. Casting precedent to the winds, Morris L. Cooke, director of the Department of Public Works of Philadelphia, has issued an annual report which is absolutely unique among printed records of municipal work. Nothing less can be said of it than that it is epoch-making—not so much in the matter that it contains as in the mode of its presentation. It leaves the dry trail of inconsequential detail and dull statistics, along which many a weary reader of the usual annual report has plodded, and strikes boldly at the broad problems which the department has faced and which still await solution. And in doing this it substitutes for the stilted, incoherent and confusing treatment which has characterized so many other annual reports, the methods of a well-edited and profusely illustrated magazine. Mr. Cooke has accomplished the unbelievable. He has humanized an engineering report.

To do this has required both skill and courage, but the outcome can safely be predicted. Mr. Cooke's message is told in such an interesting and original style that it will be widely read by the people of Philadelphia. They will understand what the department has done and proposes to do, and, understanding, will give their solid backing to the work in hand. Thus the great power of publicity has been adroitly employed to serve the best interests of public works development, and it is in this respect that the report merits careful study by city engineers elsewhere.

In the first place, no one would suspect that the pamphlet was an engineering report for its title is "Plain Talk," and under this caption on the front cover are printed the subjects discussed, such as "Economies, Waterwaste, Pigeons, Graft, City Plan, etc." The pigeon motif again appears in picture and text on the first page. A bird which has nested in a window of City Hall, in view of passing thousands, is likened to the municipal employees who must go

about their work in full view of the city's population. The skeptic asks, "What has a pigeon to do with public works?" The answer is, "Nothing." It is merely a clever introduction to arouse the reader's curiosity at the outset and make him scan the report to find out what it is all about.

In the succeeding pages the work of the several bureaus is discussed in readable style, and the many photographic reproductions add to the human interest of the document. It all makes interesting reading—how the department saved \$3,000,000 in the three years to date; how the system of awarding contract was revised and the political czars dethroned; how the employees of the department were made to feel an interest and responsibility in their work by means of a prize competition; how the bureaus of water, sewers, and highways are co-operating to make Philadelphia unrivalled as a city in which it will be a pleasure to live. And so on to the end of the report.

Engineers have not yet begun to realize the possibilities of publicity. Only when they do will they begin to receive that degree of popular support for their work which is their due. On this subject Mr. Cooke's remarks are very much to the point. He says, in part:

"In offering employment to an engineer, other things being equal, I want what might be called a good advertiser. You can secure appropriations for work more easily when it is well advertised. In the matter of writing reports there is the greatest room for improvement. Too frequently in the past they have been stereotyped in form, weighted down with page after page of dry and almost meaningless figures and written in a style forbidding to all except a small professional class of municipal administrators. We have made the effort to retain in the body of our report only such matters as are of more or less general interest and to shape them up so as to command that interest. Tabular and other technical material, interesting only to a restricted class, has been put in appendices. Many data of this kind formerly published in our annual reports, have been placed on file in the bureaus where they can be consulted by the relatively few interested."

The report of the Philadelphia Department of Public Works is an illuminating example of what can be done with a year's record if only the executive in charge can "see the story" in his work and then tell it in words that will command the reader's attention. To the readers of the Engineering Record this subject is not new. The editorials "How Can Annual Reports be Improved" (Feb. 27, page 254) and "More About Annual and Other Reports" (April 24, page 512) made a plea for turning to good use the appalling amount of waste effort that is now put into the ordinary public works document. If engineers in other cities will take the Philadelphia lesson to heart and, what is most necessary, have the courage to turn out of the rut formed by misguided precedent the cause of the civil engineer and his work will receive a decided impetus.

Mitering Lock Gate at Keokuk Presents Novel Features

Type of Framing Gives Unusually Stiff Structure to Carry Dead Loads and Resist Warping Stresses Due to Operation—New Methods of Final Adjustment and Hanging of Gate

By B. H. PARSONS

Member, Hugh L. Cooper & Company, Consulting Engineers, New York, and During Construction, Mechanical Engineer of the Mississippi River Power Company

THE MITERING GATE of the Keokuk lock presents unusual features of design, methods of construction and mode of operation. Two years in regular service, uninterrupted during the navigation season, indicates success, and a brief description is now offered as a contribution to the literature on lock gates.

The feature that has attracted most attention is the type of framing for carrying the dead loads and giving the structure unusual stiffness. In the anchorage and hinge block, the final adjustment of the leaves, the details of the operating mechanism and in other particulars lock designers will recognize departures from customary practice.

This lock and the connecting dam are located at the foot of the Des Moines rapids of the Mississippi, at Keokuk, Iowa. The old Government canal, extending 7 miles upstream, with its three locks and embankment is submerged a sufficient depth for navigation by the pool above the new dam, now called Lake Cooper.

The act of Congress authorizing the hydroelectric power plant in the Mississippi at Keokuk stipulated that the power company should build, at its own expense, for the Government, a new lock and dry dock and appurtenances thereto, including an independent power plant to serve the lock, dry dock and repair shops. Proceeding un-

der this act, the lock, dry dock, lock power house, etc., were designed by the writer and built by the Mississippi River Power Company, under the direction of its chief engineer, Hugh L. Cooper. The whole constitutes a self-contained, independent plant, operating under its own power, and is now the property of the United States Government.

GENERAL DIMENSIONS

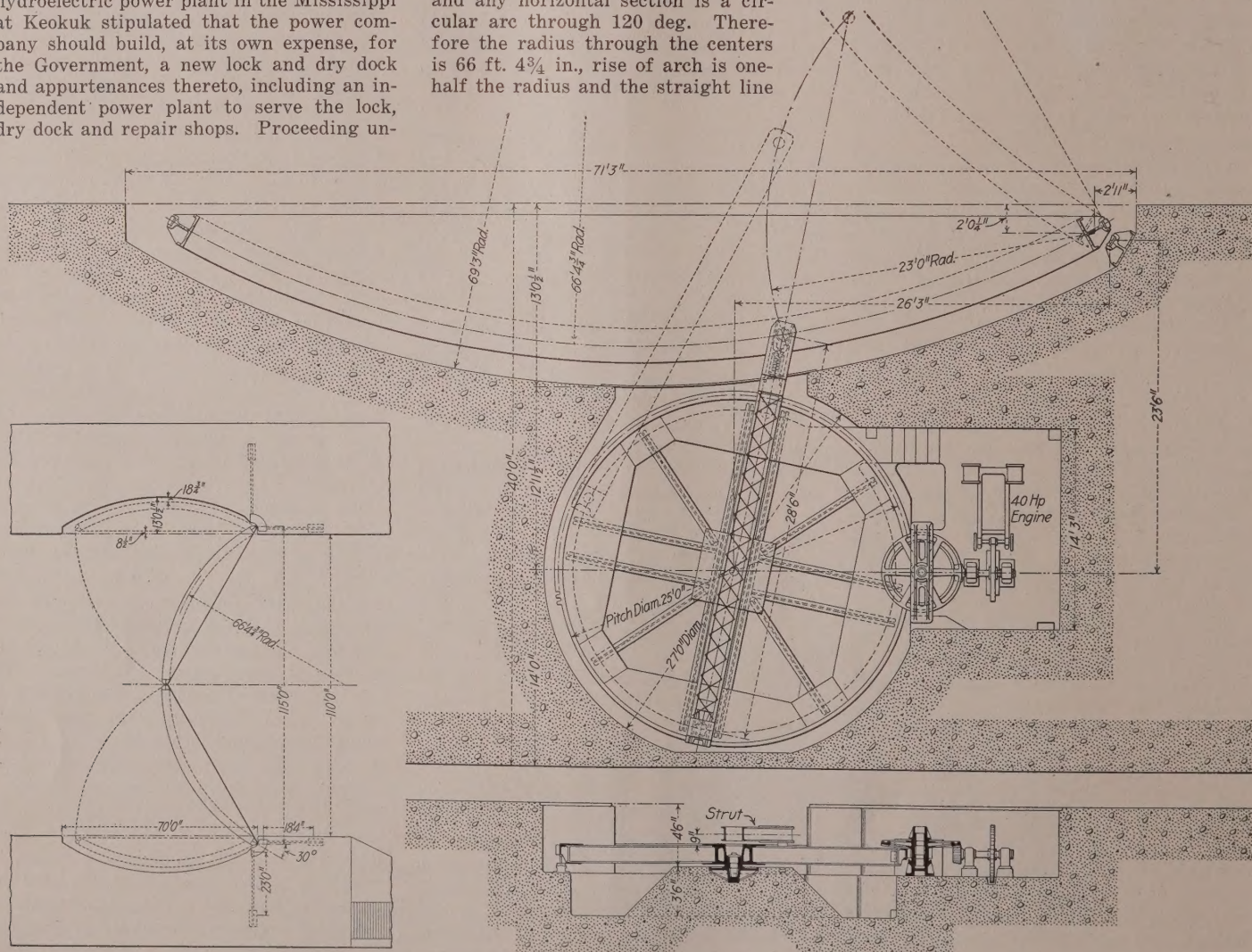
The lock is 110 ft. wide and 400 ft. long in the clear, and the maximum lift at low stage is 40 ft. The minimum depth over gate sills is 8 ft. at the upper gates and 7 ft. at the lower gate. The upper gate, guard gate and adjoining dry dock gate are floating gates of a novel type and will be described in a separate article. The lower gate is of the usual type of mitering lock gates and is the present subject of discussion.

The distance between centers of bearings at the quoins is 115 ft. When closed the upstream surface of the gate is cylindrical and any horizontal section is a circular arc through 120 deg. Therefore the radius through the centers is 66 ft. 4 $\frac{3}{4}$ in., rise of arch is one-half the radius and the straight line

distance between centers of bearings on each leaf is also 66 ft. 4 $\frac{3}{4}$ in. The height of the gate from center to center of main frames is 48 ft.

GENERAL FEATURES

Each leaf is composed of the following parts: Thirteen horizontal arch ribs curved to the arc of a circle and spaced equally 4 ft. apart. These ribs are framed together from top to bottom by heavy girders forming the quoin and miter posts and by nine lines of intermediate verticals. Quoin and miter posts are reinforced, and pressure from the arch ribs is distributed to the bearing plates by heavy steel castings in a continuous line from top to bottom. The frame thus formed is covered on its convex, or upstream side, by steel-plate sheathing, which is the waterproof skin. The curved shell of the leaf, as just described, is reinforced by heavy framing on its concave or downstream side. This framing extends to the chord of the arc so that a horizontal section is a circular seg-



GENERAL PLAN AND DIMENSIONS OF GATE—LOCATION AND ARRANGEMENT OF BULL WHEEL AND ENGINE

ment, and in conjunction therewith the top and bottom ribs are extended downstream to the same plane.

A displacement chamber occupies the central panels at the bottom of the leaf, and is equipped with a manhole and means for removing leakage.

ELEMENTS OF DESIGN

The elements of design are:

1. Waterproof skin on the upstream surface. This arrangement has considerable advantage over that in which the plates are attached to the downstream side, particularly in case of heavy water pressure due to high head; viz., the rivets are not subjected to direct tension by the water pressure; all rivet heads formed during erection are on the pressure side, that is, their shanks are upset in the right direction for effective calking; and butt straps at joints between the plates are located so that they likewise are calked on the pressure side.

2. Water pressure exerted against the gate in radial lines and the resulting stresses carried by arch ribs in direct com-

tact with the miter sill and subjected to a horizontal, downstream force applied at the top of the miter post. This force would cause definite moments in the main diagonal girders, one of which would act as a simple beam supporting the other, which would act as a cantilever. Evidently, therefore, it is reasonable to assume that the principle involved in this design renders the structure statically determinate in respect to all forces which may be applied to a single leaf alone. When both leaves are acting as a three-hinged arch to sustain water pressure, stability in vertical planes may not be definitely determined, but, even in this case, the downstream frame contributes largely to such stability. Further study of the action of forces in mitering lock gates, and the application of this design thereto, will indicate that an effort was here made to evolve a skeleton frame which would eliminate much that has remained uncertain and indeterminate.

BEARINGS AND ANCHORAGE

The foundation for each leaf is a cast-iron base plate embedded in concrete and

gate. This adjustment was made after the gate had been entirely completed, adjusted and closed. The miter sill contact is of cast-steel and is rigidly attached to the leaf.

The gate is of steel throughout, except as noted, and the quality of materials entering into its construction is the best obtainable.

LOAD ASSUMPTIONS

Five conditions of loading were considered:

1. Dead load of gate leaf when hung on its hinges in air.

2. Dead load of gate leaf when hung on its hinges in high water; i. e., dead load with maximum uplift from the displacement chamber.

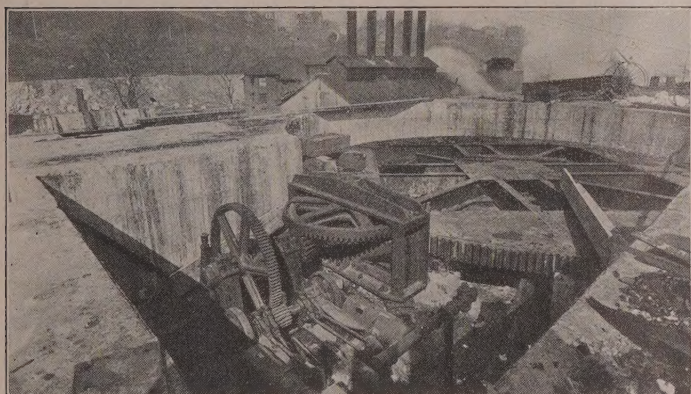
3. Gate closed and subjected to sufficient power applied at the top to open it against a 1.25-ft. head of water at low stage.

4. Gate closed and subjected to static water pressure, with lock chamber filled to the highest level and water excluded from contact with the gate on its downstream side; contact at miter posts, but not at miter sill.

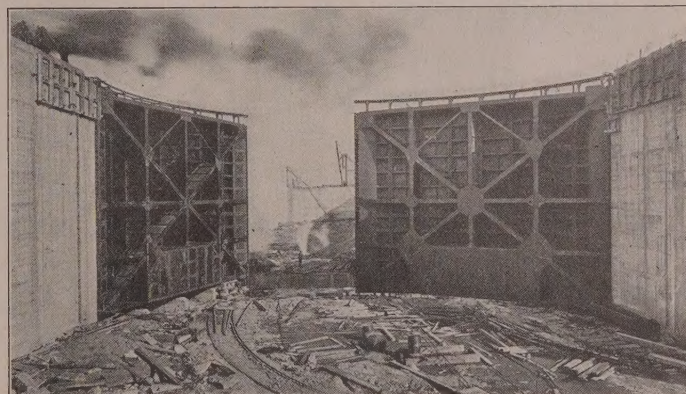
5. Same as Case 4, but with contact at both miter sill and miter posts.

DETAILS OF FINISH

The gate was built by the Chicago Bridge & Iron Works and was erected in place, adjusted and put into operation by the Mississippi River Power Company. The structure exhibits such excellence in workmanship



LEFT—MECHANISM AND GEARING BETWEEN ENGINE AND BULL WHEEL IN PIT



RIGHT—ONE LEAF SWUNG, THE OTHER SUPPORTED ON TEMPORARY PIERS

pression without flexure. This simplifies the whole structure. The ribs are of plate girder section and uniform depth.

3. Stability in vertical planes provided in an unusual and effective manner by the heavy girders of the downstream frame in conjunction with the quoin and miter posts and the intermediate verticals. The intermediate verticals are of the usual form, but the quoin and miter posts differ from some important gates of recent design in that they are of definite girder section and continuous from top to bottom.

4. The use of heavy framing on the downstream side in the form indicated. This frame consists of the quoin and miter posts, the top and bottom horizontal girders and two main diagonal girders, with secondary members making sub-division into four panels. The top and bottom members and the main diagonals are heavy plate girders of considerable depth at the middle and tapering toward each end. The functions of this frame are: To sustain the entire weight of the leaf when hung on its hinges, with no dependence on the skin plates to resist shear; to resist and prevent warping of the leaf under any circumstances, with particular reference to power applied at the top to open the gate when a small head exists between water levels in the lock chamber and the lower pool; and to preserve alignment of the leaf during erection and so avoid troublesome and uncertain expedients to compensate for the deformation inherent in a cylindrical leaf.

To illustrate one phase of the utility of this frame, assume that one leaf is in con-

carefully finished to receive the nickel-steel pintle which is 18 in. in diameter. A large steel casting is built into the heel of the leaf and is fitted with a bronze bushing for the pintle. The anchorage casting is of steel and is provided with a bronze bushing for the main pin. This block is without means for adjustment, is supported by a cast-iron bed plate and is anchored by eyebars with cast steel bearings and anchors. Reaction castings at the quoins are of iron, proportioned to transmit pressure to the masonry within the prescribed limits. These castings contain a continuous rectangular recess for the contact plates. The steel castings which are a part of the quoin and miter posts are shaped and finished in like manner to receive the contact plates.

CONTACT PLATES AND SILL

The contact plates are of steel, accurately finished all over and held in place by stud bolts. During erection these stud bolts were opposed by small jack screws in a manner to insure perfect alignment and contact. The space behind the contact plate was then filled with Babbitt metal.

The miter sill is of oak, bedded in concrete and adjusted for position to a mid-range of temperature and deflection of the

and precision of fit and alignment throughout as to reflect great credit upon the builders. All castings are machine finished at joints and junctions with other parts, and have drilled holes with fitted bolts. The ends of arch ribs are milled to fit.

The edges of plates forming the watertight skin are not milled and do not abut. They are sheared to dimensions which leaves clearance between adjoining plates, and all joints between these plates are provided with fitted outside butt straps bevel sheared for calking all over. Except for connection to castings and machinery parts, all rivet holes are punched holes—this upon guarantee by the builders of a higher degree of accuracy by punching than by reaming or drilling. The result was entirely satisfactory.

ERECTION

Reaction castings at the quoins were held in alignment during the placing of concrete by specially built steel posts bolted to the base plates and shored at the top. Each leaf was erected upon temporary concrete piers, and screw-actuated wedge blocks were employed to support the structure. The miter post end of each leaf was raised $\frac{1}{2}$ -in. above normal to compensate for deflection when

Each leaf was kept in exact vertical alignment during erection and the axis of rotation was exactly plumb, the anchorage block remaining under light pressure applied to produce equal strain in both sets of eye-bars. When the wedges were removed, that is, when the leaves were first hung in the position occupied during erection, each leaf was less than $\frac{1}{8}$ -in. out of plumb transversely at the miter post end. It will be

difficult such reversal and all load changes, better than if internal strains were transmitted through screws, wedges or other adjusting devices. The gate has remained in perfect adjustment up to this time, and is expected to "stay put." There is practically no leakage through the gate or its contacts, a fact which has prompted much favorable comment.

COMPRESSED-AIR OPERATION

All mechanical operations throughout the lock are actuated by compressed air. Air is compressed in the lock power house, located in the portion of dam which connects the east wall to the main power house. Two compressors are installed, and each is belted to a 200-hp. water turbine. There are two receivers, and the hydraulic governors are controlled so as to maintain a constant receiver pressure of 100 lb. per square inch. The whole constitutes a duplicate plant, either of which is of sufficient capacity for the work involved.

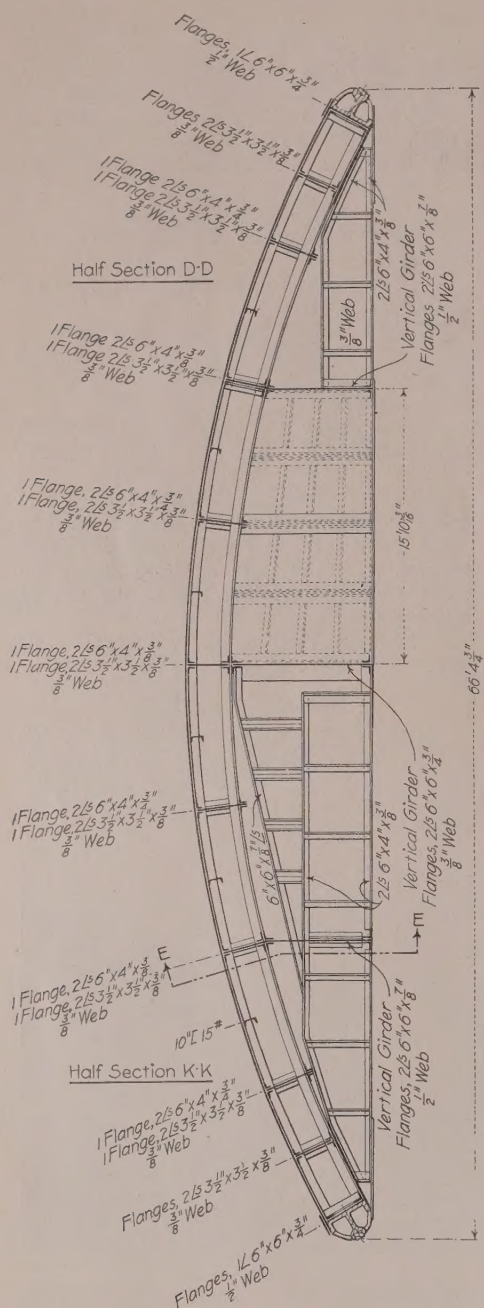
Compressed air is conducted to a main header in the lock operator's house, located on the east wall near the guard gate, whence it is piped separately to each engine and machine in the lock. Every such air supply pipe contains a throttle or control valve in the operator's house, and the stems of these valves are extended in such manner that their handles are mounted on a switchboard in a convenient arrangement.

GATE-SWINGING MACHINE

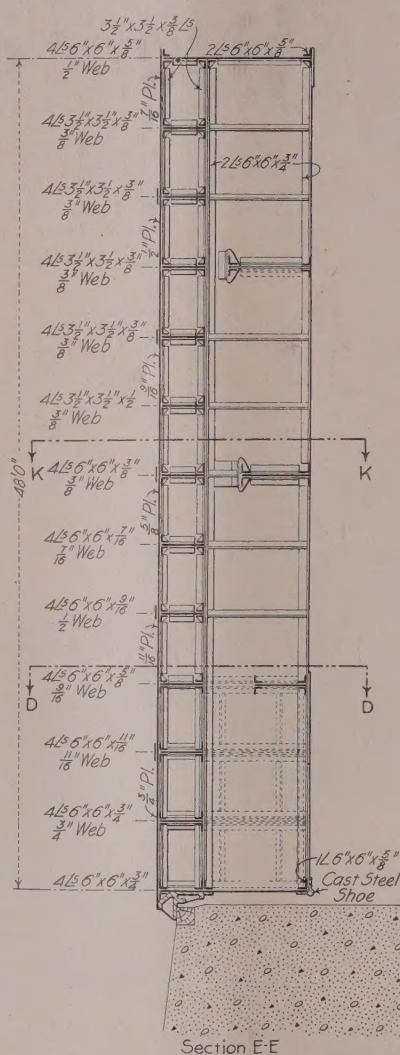
The gate-swinging machine consists of a large horizontal bull wheel, coupled to the gate by a connecting rod in the form of a channel-bar strut, and geared back to a 40-hp., double-cylinder, reversible, link-motion-engine. This apparatus is mounted in a pit at the top of the lock wall. The engine is covered by a house with openings large enough to remove any part, and the bull wheel is covered by removable cement sidewalk construction with bull's-eye lights.

The connecting rod is not of rigid length between pin centers, but may be compressed or extended 1 in. either way from normal, either change being resisted by the compression of a single spring. This is a shock absorber for gear teeth, etc., allows for expansion and contraction of the gate and permits of small obstructions along the miter sill or between the gate leaves without damage, a statement which was proved one day by an 8-in. log caught squarely between the leaves.

The bull wheel revolves through 180 deg. for a complete movement of the gate, and the connecting rod is at dead center at each end of the stroke. This provides slow speed and great power at the beginning and end of the swing, with highest speed and least power during the middle of the movement. This application of power and speed



SECTIONS SHOWING MATERIAL AND OUTSIDE VERTICAL GIRDERS



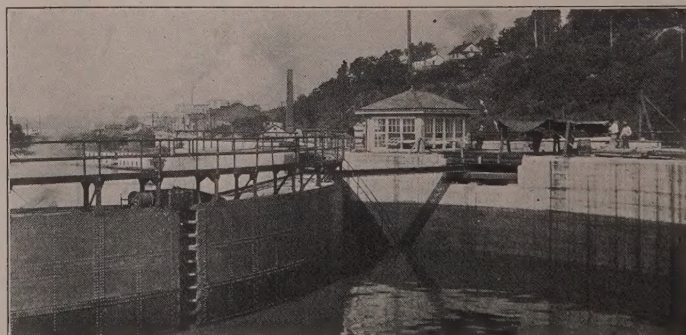
Section E-E

hung on its hinges. Adjustment of the anchorage after the leaf was hung was accomplished by means of carefully shaped steel plates placed under the curved anchor pedestals shown in one of the drawings, the leaf being jacked up during this process. Trenches left in the lock walls for the eye-bars and anchor pedestals were then filled with sand and covered over flush with 4 in. of concrete.

noted that the usual means for adjusting the anchorage was not employed, but gave place to a more simple, perhaps more permanent, method. When a leaf is swung into its recess, the transverse component of the reaction at the hinge pin reverses from tension to a small amount of compression. The anchorage block is a single casting, and was bolted fast to its bed plate after adjustments were completed. It should, therefore, en-



CONTROL LEVERS AND INDICATORS IN OPERATOR'S HOUSE



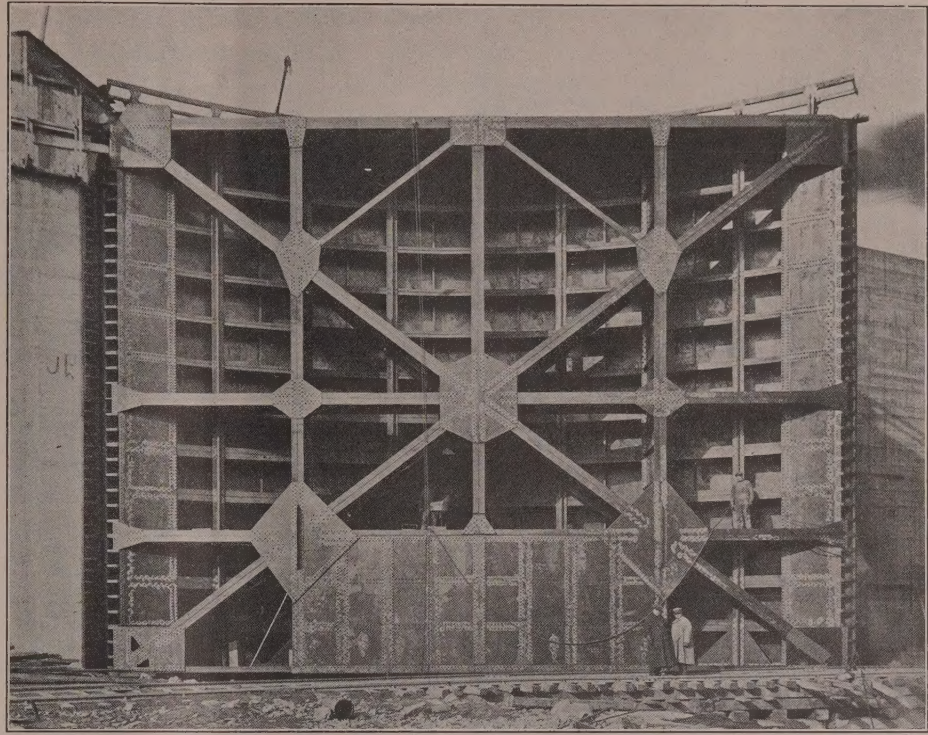
GATE CLOSED AND LOCK PARTLY FILLED WITH WATER

is the outstanding feature of design in this machine, and seems well adapted to the moving of a swinging mass of 300 tons through a fixed distance. It is not possible to slam the gate against the miter sill or the lock wall.

This gate-swinging machine was designed for the Keokuk lock prior to any knowledge of the apparatus to be used in the Panama Canal locks; the machines are identical in principle. One leaf is equipped with a machine which, when the gate is closed, grips a gudgeon on the other leaf and forces the two into exact alignment and contact, as indicated in the detail drawing.

CONTROL

The main throttle valve of the engine, and valves for the reversing cylinder and the miter-forcing machine, are controlled by the operator at the switchboard, some 500 ft. distant, indicating necessity for an automatic rig to prevent over-running the bull wheel. This is accomplished by a four-way limit cock interposed between the main supply pipe and the pipes serving the reversing cylinder. The limit cock is con-



DOWNSTREAM VIEW OF LEAF SHOWS DIAGONAL GIRDERS—BOUYANCY CHAMBER AT BOTTOM

trolled by a circular slot running half way around the bull wheel, with cam motion at each end. Its action is to reverse the engine immediately after the dead center point is reached, irrespective of the position of the valve handle at the switchboard.

The machine then runs backward through the length of the cam, about 10 in., when it reverses to forward motion again, and this oscillation continues until the main throttle is closed.

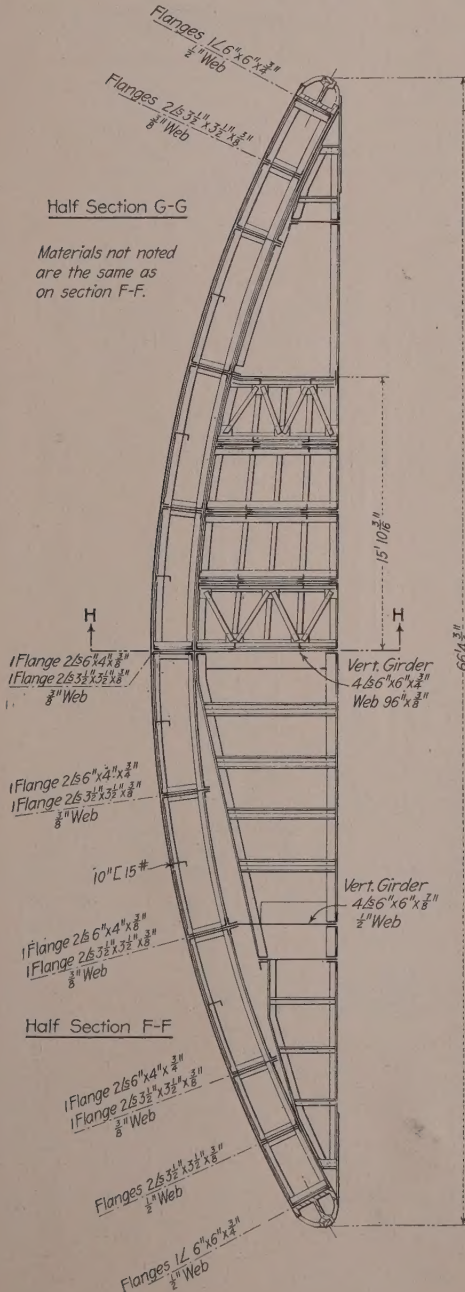
A system of electric indicators insures safe operation at all times. Electric contacts are made at the limits of motion in the miter-forcing machine and the reversing cylinder of the engine, causing distinctive colored lights to appear or disappear on the switchboard as the case may be. Similar contacts are made by the bull wheel throughout its revolution, which always indicate the position of the gate by lights on the switchboard. These lights are white for intermediate positions of the gate, green when approaching the dead center point, green for a few inches beyond dead center, and then red.

The apparatus is in successful operation and seems to demonstrate the practicability of remote control of machinery of this kind actuated by compressed air.

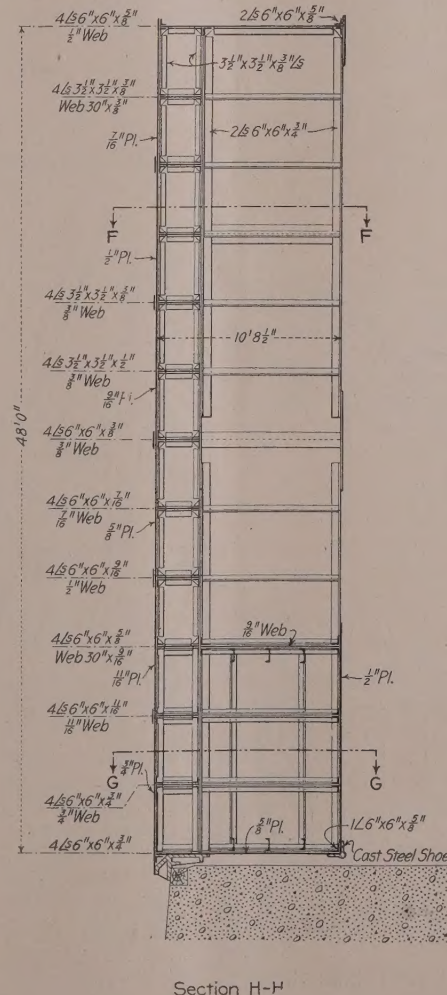
The entire work was conducted under the direction of the Corps of Engineers, U. S. A. Negotiations with the office of Chief of Engineers began in 1906, General Mackenzie being Chief of Engineers at that time.

The importance of this work in the Mississippi River, where large sums of money are spent continually for improvement of navigation, caused the Chief of Engineers' office to give wide publicity in advance to the dimensions of the lock, the depth over miter sills and the general layout. Public hearings were held from time to time, when the proposals of the power company were given to the public for criticism. After these hearings were concluded, and the various reports of the engineer boards were completed, the plans of the work as constructed were approved by the Chief of Engineers and the Secretary of War.

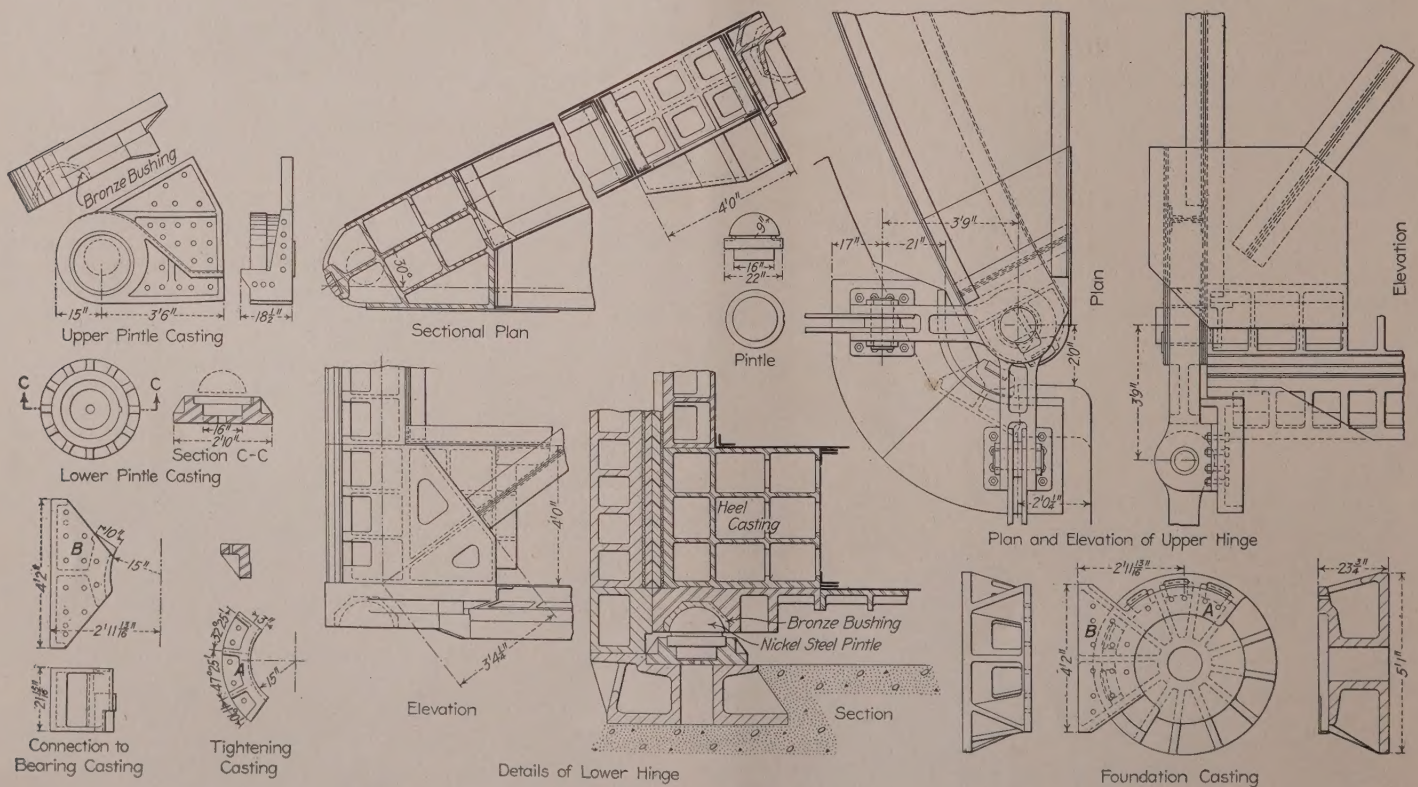
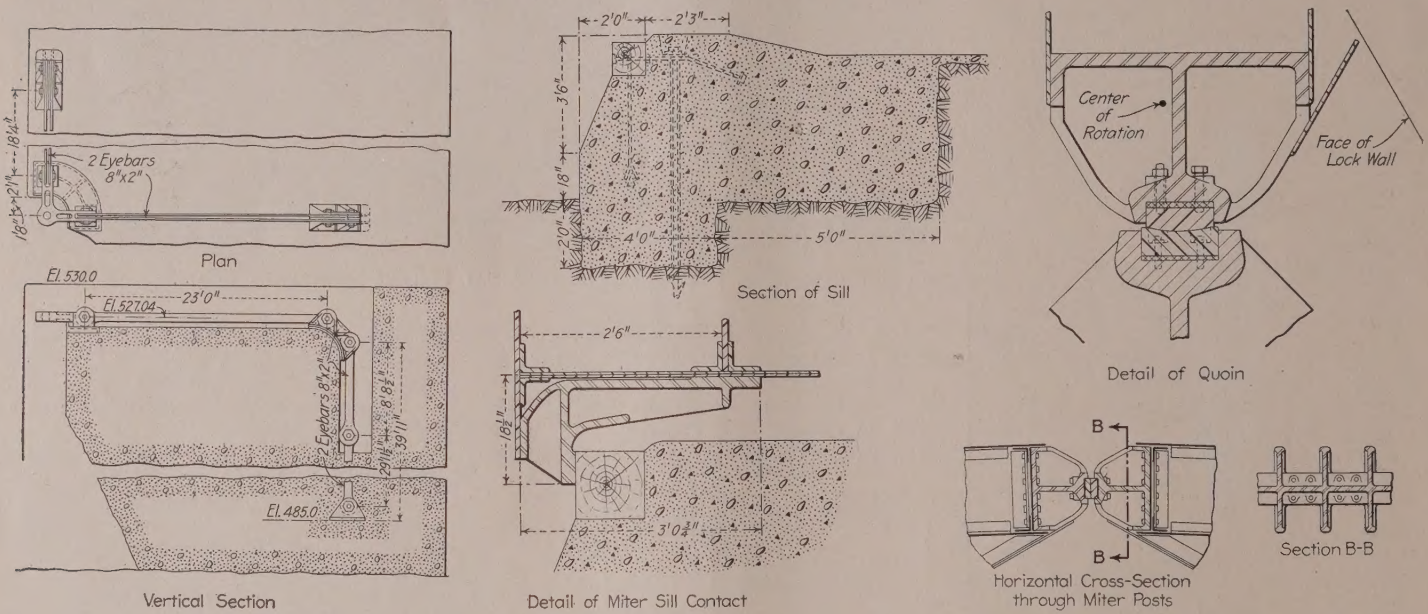
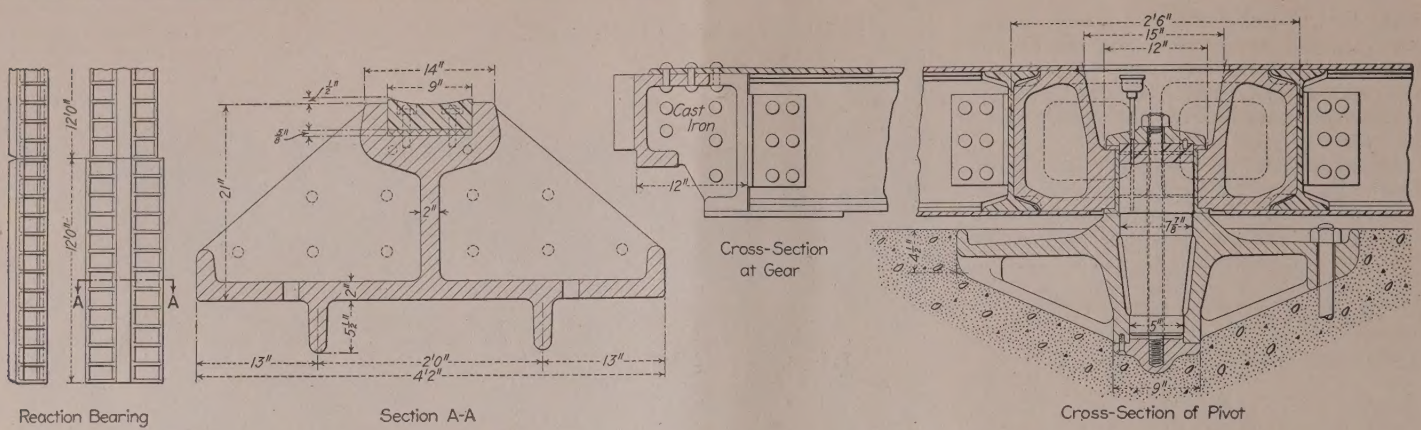
The actual construction was carried out during the time General Bixby was Chief of Engineers, and the district engineer officer in immediate charge was Charles Keller, major (now lieutenant-colonel),



SECTIONS SHOWING MATERIAL AND CENTER VERTICAL GIRDER



Section H-H



Corps of Engineers. Montgomery Meigs, U. S. civil engineer, was resident engineer for the Government. All plans, details of construction, materials, workmanship and the finished work were exhaustively analyzed and approved and finally accepted by the War Department. The attitude of the army engineer officers throughout the period of eight years on this work was characterized by an admirable and strict

Tar Paint Proves Better than Lead Paint on Pipes

Reclamation Engineers Try Various Coverings to Withstand Water on the Penstocks and Draft Tubes at Minidoka

WHERE water comes in contact with the paint applied to steel penstocks and draft tubes of the Minidoka power

formula for red-lead paint, obtained from one of the largest paint manufacturers in the country, was adopted, the lampblack being used as a hardener for the surface:

First coat: 30 lb. of red lead per gallon of linseed oil, using one-third boiled and two-thirds raw oil.

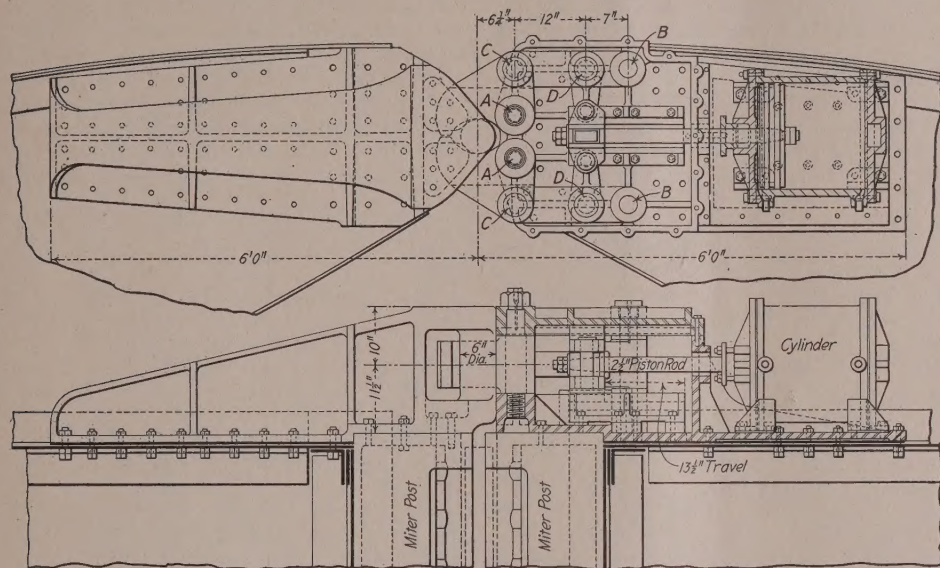
Second coat: Same as above, with 4 oz. of lampblack per gallon.

Third coat: Same as above, with 4 lb. of lampblack to the gallon.

Paint was applied according to this formula during the winter of 1912-13. After part of this work was done the chief electrical engineer suggested that we try the material used on the Los Angeles aqueduct, and in accordance with his instructions we ordered water-gas tar for the first coat and coal-gas tar for the second and third coats. This was applied to penstock and draft tube 1.

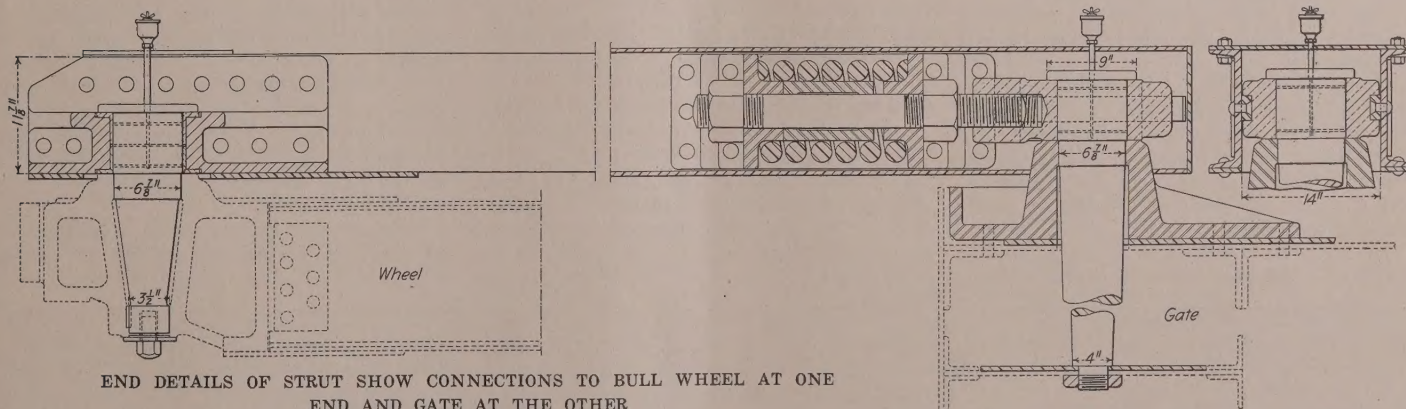
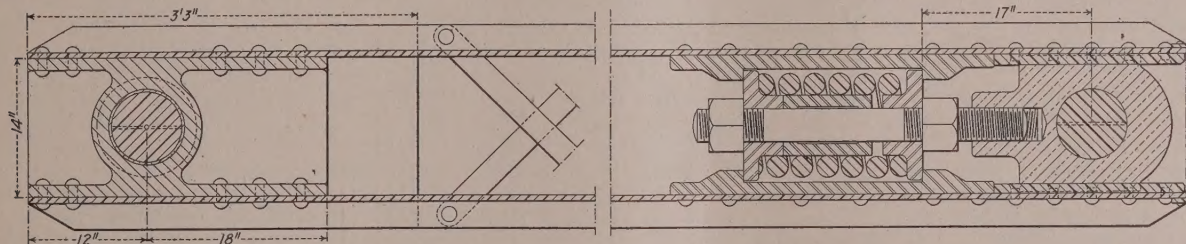
RED LEAD VS. TAR PAINT

At the end of the 1913 season the red-lead paints applied according to the above formula showed decided deterioration where in contact with water, while the tar was in very good shape except for slight rust spots around some of the rivets, where cleaning evidently had not been properly done. At the end of the 1914 season the lead paint had almost entirely disappeared where exposed to water and the tar paint was in good condition on the penstocks, but was apparently getting rather thin on the outside of the draft tube. Where the red lead does not come in contact with the



MITER FORCING MACHINE AT TOP OF MITER POSTS

A and B are pivots, C and D are movable pins. The jaws are pivoted around A. Links join C and D, and D and B. When the piston moves backward D is drawn in and C, therefore, rotates backward around the pivot A, thus opening the jaws.



END DETAILS OF STRUT SHOW CONNECTIONS TO BULL WHEEL AT ONE
END AND GATE AT THE OTHER

fairness which will always be remembered by the engineers of the power company with genuine pleasure.

[The second article by Mr. Parsons, describing the new type of submersible lock gate, at Keokuk, will appear in an early issue.—EDITOR.]

FUNDS FOR HIGHWAY MAINTENANCE in California which were received during the period Jan. 1, 1915, to June 30, 1915, from automobile license taxes, amount to \$1,722,763, according to the superintendent of the State motor vehicle department.

plant, tar paints have been found to be a satisfactory covering, according to an article by Barry Dibble in the *Reclamation Record* for September, from which the following extract, practically in full, and including the table giving costs of cleaning and repainting, has been taken.

The shop paint was of red lead, or iron oxide, and oil. A further coat of red lead and oil was applied on the job, after assembling and riveting the pipes. After two years' service an examination showed that this paint had practically disappeared.

After considerable study and experiment, with unsatisfactory results, the following

water, as is the case on the upper part of the exterior of the draft tubes, it shows no deterioration and is now in excellent condition.

During the fall of 1914 the parts exposed to water on all the draft tubes were scraped, cleaned and repainted with water-gas and coal-gas tar. The accompanying table shows the cost of this work. There was a considerable variation in the condition on the different tubes, due to the fact that some had two coats of lead and some three, and also due to the fact that in some cases the weather was cold when the paint was applied, and it therefore may not have

COST OF CLEANING AND PAINTING FIVE DRAFT TUBES,
MINIDOKA POWER HOUSE

	Draft Tube					Total
	1	2	3	4	5	
Total surface, sq. yd.	170	170	170	170	170	850
Area cleaned and painted, sq. yd.	150	150	150	150	150	750
Cost of scaffolding:						
Labor	...	...	...	...	...	\$52.32
Material	...	...	...	...	...	22.74
Cost of cleaning:						
Sharpening scrapers						52.76
Labor	\$37.42	\$92.98	\$58.00	\$48.28	\$85.10	321.78
Cost of painting, labor:						
First coat (water-gas tar)	7.40	11.99	2.60	6.70	12.93	41.62
Second coat (coal-gas tar)	10.95	16.69	10.16	10.10	12.06	59.96
Third coat (coal-gas tar)	None	None	None	8.50	None	8.50
Total labor, painting only	18.35	28.68	12.76	25.30	24.99	110.08
Material (all coats)	2.40	2.11	1.60	2.40	1.88	10.39
Total cost	...	...	...	...	...	\$570.07
Cost per square yard cleaned and painted:						
Scaffolding, labor and material						\$0.100
Cleaning, sharpening scrapers, and labor						0.499
Painting—						
Labor						0.147
Material						0.014
Total per square yard						\$0.760

set sufficiently before being submerged in the water. The tar paint on draft tube 1 would under ordinary circumstances have gone a much longer time without renewing, but it was thought advisable to go over it in order to determine the condition of the tar coating and the iron underneath.

CLEANING BRUSH ON BREAST DRILL

It will be noted from the accompanying schedule that a very large part of the cost of the work was involved in the cleaning. This cleaning was done by means of steel scrapers and brushes. With the lead paint the iron pitted badly, and it was necessary to clean out the loose scale thoroughly before attempting to repaint the metal.

The rivet heads, particularly, presented a serious difficulty with these scrapers, and we found it very slow to do a good job cleaning around them. After this work on the draft tubes was finished a special brush was made up which could be fitted over the rivet heads and revolved in a breast-drill frame. This worked very satisfactorily, and it materially reduced the cost of cleaning the penstocks.

In scraping draft tube 1 we found an excellent adherence between the metal and

the tar paint, which had been on a year and a half at that time. Where it was scraped down to the metal it left a bright surface. On one patch, of about 1 sq. yd., apparently the iron had not been well cleaned before applying the paint, as it was in a place difficult to reach, and here scale had formed. This was the only place, however, where the iron had not been protected from the water. There was a marked difference in the ease with which this tar was cleaned off preparatory to repainting as compared with the work involved on surfaces which had been covered with red-lead paint, and had become pitted. It will be seen from the cost data that tube 1 was cleaned for about one-half the average for the other four tubes. Altogether the results with the tar have been most satisfactory.

There was quite a variation in the consistency of the water-gas tar purchased at different times. As ordinarily obtained it was necessary, in the cool weather during which we painted, to mix a little gasoline with it. Usually the mixture was about 1 qt. of gasoline to from 3 to 5 gal. of tar. This tar was then spread on carefully with a brush in the same manner as ordinary oil paint, it being carefully worked into all pits and around rivets. One gallon of tar covered about 30 sq. yd. with one coat. The cost was about 15 cents per gallon, about one-half of which was freight charge from Chicago to Minidoka.

The tar is rather slow in setting, even if the weather is warm. It hardens when the thermometer drops, but when the weather warms up will become sticky even after a considerable period. As most of the work was done in cool weather, it was possible to apply the second coat within 10 to 14 days. In only one case (draft tube 4) were we able to get a third coat on prior to the time when the weather turned so bad that it was impossible to do outside work. It does not appear to affect the tar to put it into the water before it is thoroughly hardened.

Test Automobiles in Detroit on Artificial Hill

Steel and Wood Structure 40 Feet High in Center of New Speedway Has 12½ and 25 Per Cent Grades on Approaches

ABSENCE of natural hills in the vicinity of Detroit on which to test automobiles led one manufacturer to construct an artificial test hill 542 ft. long, 40 ft. high and 18 ft. wide on the runway, in the

center of a ½-mile speedway. One approach has a 25-per cent grade 160 ft. long. The other end is just half as steep and 332 ft. long. At the top is a level stretch 50 ft. long. Both grades are eased off at the lower end to give the cars a more gradual start.

DESIGN OF STRUCTURE

The hill is a composite wood and steel structure designed for a live load of 50 lb. per square foot, and consists of twenty-six all-steel bents, anchored to solid concrete piers, spaced 20 ft. on centers on grades and 16 ft. 8 in. on the level stretch. The bents are composed of 8-in., 32-lb. H-beams properly braced. The horizontal members in the bracing consist of two 5-in. channel irons bowed apart at the center and secured to each other with ¼ x 6-in. batten plates. Other braces are 3 x 2½ x ¼-in. angle irons.

The main crossbeams at the tops of the bents are 12-in., 28½-lb. I-beams riveted to the angle caps of the columns, and are provided with angle clips to receive four 6 x 10-in. pine stringers, to which 3 x 8-in. planking is spiked. Continuous 10 x 25-lb. I-beam struts connect the columns. These struts are connected midway of the span by a four-angle strut. The horizontal braces between the bents and the inside of the bridge are channel irons bowed apart at the center and secured with batten plates. The diagonal members are of angle irons.

WIND BRACING

The wind bracing in the plane of the bridge floor consists of 7/8-in. round rods. At each bent and intermediate between bents occur steel angle brackets, fastened to the main crossbeam and angle struts. A 3 x 8-in. and 3 x 12-in. planking secured to these brackets forms a substantial railing on both sides of the bridge. A 4 x 8-in. pine beam bolted to the floor divides the runway of the bridge in half to avoid accidents from cars running in opposite directions.

The method of laying the planking is practically the same as that used on the speedway, where 3 x 8-in. creosoted planks 16 ft. long are spiked to 4 x 4-in. sleepers. These are butted alternately except on curves, where the joints are even and reinforced. A 3/8-in. space between planks is left to give air space and provide a good hold for the tires.

The hill and speedway were constructed by the engineering department of Dodge Brothers, motor car manufacturers.



ARTIFICIAL HILLS CONSTRUCTED BY AUTOMOBILE MANUFACTURER FOR TESTING CARS ON TWO GRADES

Road Building's Immediate Opportunities Lie in Revised Legislation and Sound Financing

A. N. Johnson and Nelson P. Lewis, Speaking at the Pan-American Road Congress in Oakland, California, This Week, Show Need for New Laws and Short-Term or Serial Bonds

State Road Laws Should Centralize Authority

A. N. Johnson Sets Forth Principles Which Will Bring Order Out of Chaos in Highway Legislation

CENTRAL control over all roads by a State highway department, recruited from the ranks of skilled technical men and not political manipulators thinly disguised as "practical men", must be the basis of highway legislation which is designed to produce good results at reasonable cost. This is the principle enunciated by A. N. Johnson, highway engineer of the Bureau of Municipal Research, of New York City, in a paper presented at the Pan-American Road Congress in Oakland, Cal., Sept. 13-17. In fact, the road laws in almost every State, according to Mr. Johnson, are in such a hopeless snarl as the result of piecemeal legislation, special statutes and amendment heaped on amendment that a general repeal of State laws and a re-enactment on a logical basis is the only way to put an end to the confusion that is now almost universal throughout the country. What is needed is a highway law that has been so carefully considered as to make it unnecessary for the Legislature each year to make vital changes. Mr. Johnson's views regarding the essentials of such a law are given below.

CONTINUITY OF POLICY DESIRABLE

The law should provide for a proper organization or central authority and give to it sufficient power to promulgate by rules and regulations much that is now detailed legislation. Such authority should be placed with the State highway department whose organization, to be effective, must be such as to secure continuity of policy and employment and retention of trained highway engineers. The State department, as here contemplated, is to have more than the control of merely a restricted system of State roads. It is to have general control of all the road work and the road policy of the State.

LOCAL ADMINISTRATION INEFFECTIVE

The many special laws for the expenditure of bond issues indicate clearly the appreciation of the inadequacy of the usual road machinery to carry out effectively road improvement on the scale that is demanded to-day. The question that arises is to what extent have the devices that have been substituted for the regularly organized road administrative methods remedied the defects? Do these special road laws and bond issues provide a satisfactory solution?

During the past ten or fifteen years a noticeable feature of road legislation has been the provisions that have been made for road work to be paid for by local bond issues. The reasons leading up to such legislation, which has involved in the aggregate hundreds of millions of dollars in bond issues, is manifestly to be ascribed to the

great public interest and desire for improved roads.

The provisions that are made for an organization to carry out the work are significant. In a majority of cases a special board of commissioners is created and complete organization provided; in others, while the regular officials may have general control, they must employ an engineer or skilled superintendent. In every instance an attempt is made to remedy the defects of the usual road machinery by which no skilled supervision is provided, and which it is realized is necessary when the proposition is to spend a comparatively large sum of money on a few miles of road.

This class of legislation includes the provisions for the establishment of special road districts and organizations to spend particular bond issues. They vary from a road system for a county to the formation of a restricted district for the improvement of but a single road. Usually the work to be done and the amount of money to be spent are submitted for approval to the electors resident within the area from which the funds are to be raised, many laws providing that only voters who are property taxpayers are entitled to vote.

ORGANIZATION SHORT-LIVED

The organization provided by most of these laws exists only during the period of construction. Thus the skilled control which these special laws secure in a varying degree, at most, extends but a short period.

Beyond providing means for raising revenue and the machinery for expending the same, little or no thought has been given them. No provision is made for continuing maintenance. No fixed income is provided on which to make plans for future work. No definite information is collected on which to base estimates for such an income. Long-term bonds are thoughtlessly voted for short-lived structures. The simplest fundamental economic principles are violated without giving them a thought.

ROADS REQUIRE BROAD STUDY

Proper road development to-day requires the careful consideration of economic conditions over a comparatively wide area. There must be a careful study made to secure a road system such as will, when completed, meet the traffic needs and for the construction of which a carefully considered plan for the distribution of cost has been worked out. The spasmodic and localized road improvement attempts can fit into such a scheme only by accident. Sometimes the wrong road is chosen; other times it is not properly dimensioned; but in any event little or no thought is given to the part the road will play in a comprehensive road development plan.

More often error is found in the type of construction selected. With so many kinds of construction, each calling for special materials, all of which are actively advertised, the result frequently is the adoption of a

type of pavement which represents not what is best for the road but what company employed the most persuasive salesman.

BAD ENGINEERING PRACTICES

It might be thought that as most of these laws usually provide for the employment of an engineer supposed to be skilled in road construction, there could be no serious blunder made as to the type or manner of building the road. Due, however, to the essentially temporary character of the employment afforded and to a lack of understanding in the minds of the people generally as to the necessity for securing high-grade service, there have arisen practices by which apparently some small saving is made but which prove most wasteful.

The shrewd, careful men usually selected to have administrative control of these special road enterprises have had no experience whatever in road construction work and believe they pursue a very commendable course when they auction off the engineering, giving it to the engineer who will take the job for the least money. This short-sighted policy, saving perhaps a few hundred dollars, costs the taxpayers paying for the special work many thousands of dollars through the honest but misguided management of men selected to safeguard their interests.

The selection of the proper type of road is far more of a scientific problem to-day than it was twenty years ago. The changed traffic conditions which make it difficult to select the type of road, make it also impossible, when determining the roads to be improved, to consider but a small area.

CONCLUSIONS

It is evident that if a locality is to bond itself for road construction the greatest benefit can accrue to such locality only if it chooses wisely both as to the location and the character of the work to be done. These questions require broad experience, and local effort has not been equal to the task. There must be provided by the State a department capable to advise and direct localities and with authority to prevent unwise expenditures as well as to supervise necessary improvements.

If the proper administrative methods are to be made possible there must be abolished a vast number of small independent units which now exist, with their horde of minor officials selected by ballot. In general there must be reposed in a central State department power to make rules and regulations which now constitute a great bulk of legislative enactment, too often the results of trading and political expediency. The central authority should be charged with the development of policies for the expenditure of all road revenues. Such a department to be effective must be freed from political manipulation, and skilled men must be in control so that a continuing policy may be possible.

Road work is no longer a neighborhood concern and cannot successfully be so administered, but must be controlled by a properly organized, strong central authority.

Life of Highway Improvement Should Limit Term of Bonds

Nelson P. Lewis Shows Economic Fallacy of Long-Term Bonds for Short-Lived Structures in Road Building

LONG-TERM bonds for short-lived structures were denounced by Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment, New York City, in a paper on "Highway Indebtedness", presented at the Pan-American Road Congress in Oakland, Cal., Sept. 13-17. The justification for debt, Mr. Lewis said, must be based upon benefit which will be permanent or which will at least extend over a period of years, and also upon the ownership of unencumbered property, or sources of income which may be depended upon to provide the interest on the debt and its liquidation at maturity.

There has been a disposition to issue highway bonds for long periods, frequently for fifty years. For such part of the work as is really permanent, such as the widening or straightening of old roads, or the improvement of their grades, this may be proper, but for that part of the work which will be short-lived, such as the wearing surface of the roads, a long loan cannot be justified.

How the Cost Mounts Up

With interest at 4 per cent the total interest payments on 50-yr. bonds will be twice the actual cost of the work. The annual amortization charges for 50 yr. on at 3-per cent basis would be 0.89 per cent, so that for every \$1,000 of original cost the State or the city would pay \$2,445. The roadway surface will have worn out long before the expiration of the 50-yr. period, yet the public at large will keep on paying. If this apparently easy way of meeting the cost of highway improvement is once begun it is likely to be continued, and even to be applied to meeting the cost of replacing worn-out surfaces. There are many cases where pavements on country roads and city streets will not last more than ten years, and if this policy of financing is continued the public will, after forty years, be paying for five different road surfaces, of which four will have entirely disappeared, and the annual expense during the decade from forty to fifty years after the original improvement was made will be 24.25 per cent of its original cost. These estimates relate only to the wearing surface itself and not to the more permanent portion of the work which will have a life much greater than ten years.

Short-term bonds, when issued for highway improvement, may be generally considered as those whose term will approximately correspond with the life of the improvement, so that the road will not be worn out before it is completely paid for. Some portions of the work will last longer than others, and bonds which will correspond in their terms with the average life of the improvement may properly be considered short-term bonds.

COST APPORTIONED

In the case of a highway improvement which is to be entirely paid for by bond issue, if 20 per cent of the cost is represented by such expense as widening, grading and substantial culverts, that portion may be considered permanent and 50 yr. would not be an unreasonable time in which to pay for it; if 20 per cent is for curbing

and for gutter paving, which might be expected to last for 20 yr., bonds issued for a corresponding term for this part of the work would be fair and reasonable; if the road surface represented the remaining 60 per cent of the cost and the surface would require replacing in ten years, it would be unwise to borrow the money to pay for that part of the work for a longer period.

The average life of the entire improvement might in such a case be considered 20 yr., and it might therefore be considered proper to issue 20-yr. bonds to pay for it. There is a fallacy, however, in this argument, as the interest and amortization charges will be constant for the entire 20-yr. period, notwithstanding the fact that the part of the work representing 60 per cent of the total cost will have been worn out in half that time, although there will still remain a portion representing 20 per cent of the total cost which will last for at least thirty years after it is entirely paid for. A more conservative plan would therefore be to limit the bonds for an improvement of the kind described to 15 yr.

As the terms of the bonds are shortened the total annual expense grows impressively larger, but it must be remembered that there is less overlapping of the different issues, and after this policy of paying for highway improvements by bond issues has been followed for a period corresponding with the term of the bonds the total amount to be provided to care for the outstanding debt will be considerably less in the case of the short-term bonds.

10-YEAR BONDS

For instance, if a constant sum of \$1,000,000 a year were borrowed for highway improvements and if 50-yr. bonds were issued for the purpose, at the end of 50 years there would be \$50,000,000 of these bonds outstanding. During this time the annual interest and amortization charge would gradually increase until it reached \$2,445,000, when it would remain constant. If, however, the funds were raised by the issue of 10-yr. bonds there would be \$10,000,000 outstanding at the end of ten years, during which time the annual interest and sinking fund charges would increase until at the tenth year they would reach \$1,322,000, when they would remain constant. Under the latter policy there would be at the end of fifty years an annual saving to the taxpayers of \$1,123,000.

It may be said that these periods are so long that such a discussion is academic, but street and road improvements are going to continue for an indefinite time. Our States and cities hope to remain solvent and must meet their financial obligations, and debts of this kind must be paid in full, so that the actual facts should be squarely faced.

ADVANTAGES OF SERIAL BONDS

To distribute the cost of street or road improvements over a term of years, and at the same time to avoid the necessity of accumulating large sinking funds which return a small rate of interest, resort is frequently had to serial bonds. In this case provision must be made for retiring a certain part of the issue each year and for interest on the bonds which remain outstanding. If \$1,000,000 of 4-per cent bonds are issued in serial form, \$50,000 falling due each year, the provision which must be made to care for the bonds to be retired and the interest on those outstanding will be as follows:

First year	\$90,000
Sixth year	80,000
Fifteenth year	62,000
Twentieth year	52,000

One advantage of this plan is that as part of the work is worn out and the value of the improvement becomes less there is a corresponding reduction in the annual burden. It is important, however, that the series shall be so arranged that the amount outstanding at any time shall not exceed the actual value of the original improvement at that time. When serial bonds are issued in such a manner that the last bond will not be retired for a long term of years or a term far in excess of the probable life of a large portion of the work the plan is uneconomic and pernicious. A striking example of the abuse of the serial bond is afforded by the case of two towns now a part of New York City, which, in 1868, secured legislative authority to improve a highway passing through both of the towns and to issue serial bonds. As these bonds were actually issued the last bond of one of the towns will fall due in 1980, and the last bond of the other town will not mature until the year 2147.

It might be feared that serial bonds would not command as good a price as would those running for a longer term, but at a recent offering of a large number of New York City bonds the bids received for serial bonds, then offered for the first time by that city, actually exceeded the price offered for 50-year bonds, both bearing the same rate of interest. It is possible that present financial conditions render a more liquid asset desirable, but the fact that the prices bid for serial bonds were better than those for long-term bonds was a surprise.

CENTRAL CONTROL OF FINANCES

Unless State and municipal authorities show a disposition to limit the terms of their obligations more nearly to the life of improvements for which they are to pay, it will probably be necessary to adopt a plan somewhat similar to that followed in Great Britain, where no obligations may be issued by any State, town or county authorities until there shall have been submitted to the Local Government Board a precise statement showing the character of the improvement, its probable life and its estimated cost. This board then determines the amount of the bonds which may be issued and the terms for which they may run, the purpose being to ensure the extinguishment of the debt within a period which is less than the life of the improvement.

Road Bonds Should Provide for Maintenance

J. F. Witt Emphasizes Importance of Having Sufficient Funds Available for Repair Work

LONG-TERM bonds, according to J. F. Witt, of Dallas, Tex., in his discussion of Mr. Lewis' paper, are popular because they require a smaller annual sinking fund. Short-term bonds and serial bonds are, however, often preferred, but the difference in what kind of bond is voted is slight compared to other adjustments that should be made before the money is borrowed. The principal fault is not whether the bonds are 20-yr. serials or 40-yr. straight, but lies more in the lack of provision for a fixed amount for maintenance and repair of the

highways constructed, thus insuring an improvement that will last with the debt. The only way to make the improvement permanent is a definite and adequate method of maintenance.

RESTRICTION NEEDED

Considering a wearing surface in keeping with traffic requirements, the nominal sum available for maintenance and repair, unless special provision has been made, is inadequate, with the result that the wearing surface is worn out long before the invested obligation is discharged.

We may feel that the evolution in traffic in the past 10 yr. will probably be repeated in the next 10 yr., and in that way make it impossible to pre-determine what fixed charge to make for maintenance and repair. In a manner this is true, but in trying to work out a method that would bring about the result suggested we will not have to go far to improve on present conditions. Some restrictions should be passed by every State that would control the issuance of bonds for highway improvement and that would make it as necessary for governing boards to fix a permanent and adequate fund for maintenance and repair, as it is to have an estimate on which to rely for the amount of funds that will be required for construction purposes.

The limitations of borrowed money for highway purposes should be governed by some fixed standard of construction, that standard to be determined by the amount and kind of traffic the highway will have to carry. The necessary number of miles and the layout also enter largely into the question, for, aside from cross-State roads that enter into most highway systems, all intermediate roads should be laid out after a thorough study of traffic zones, so that when the system is completed it will accommodate a larger part of local traffic, and not less than probably 70 per cent of the tonnage of the district that pays the interest and sinking fund made necessary for the construction of the system, thus insuring compensation on the investment. When State-aid is furnished, this plan would probably be modified, but it appears to be about the best method of controlling the expenditure for counties or special districts.

SPECIAL TAXES

In the matter of levying a special tax for the purpose of taking care of indebtedness created for highway improvement in rural districts the prevailing plan of making the levy general over the district benefited appears to be unjust. The method employed in some cities of having the abutting property owners pay for a large part of the pavement cost, appears to be an equitable adjustment that should apply to rural districts as well as to the city—not to as great an extent, for the special benefit derived would not be so great, but charge the abutting land with the greatest percentage and graduate the percentage down for a distance from the highway that would be governed by the layout of the system, until the minimum was reached, which would be the basis for the general levy applied.

All abutting property receives a greater and more direct benefit from the improvement than does property located off the road. It is therefore unjust to make the charge equal. This method of paying for the improvement would also have a tendency to reduce the present manner of distributing to certain localities a preference brought

about largely through political influence, by placing all property benefited either directly or indirectly on an equal footing, as all

property would then receive a benefit in the ratio of what it paid toward the improvement.

Self-Propelled Compressed-Air Mixing Plant Lines Sandy Ridge Tunnel Under Traffic

Car Run by Gasoline Engine Carries Concrete Materials and Pneumatic Mixer, Which Is Supplied with Air Through Line Laid in Tunnel

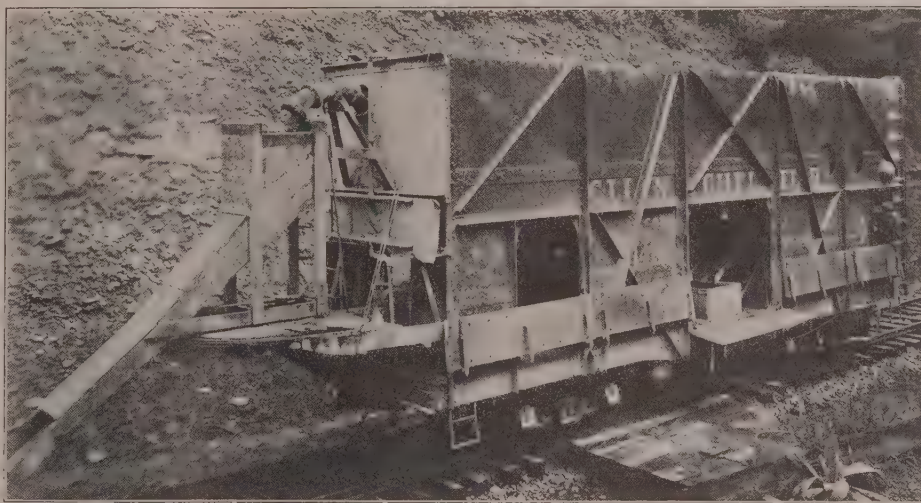
A NOVEL mixing plant which carries its own concrete materials with the mixing and placing machinery, and which propels itself at a speed of more than 20 miles an hour, thus dispensing with the services of a work train, is being successfully used by the Carolina, Clinchfield & Ohio Railway, to line a 7800-ft. tunnel without interrupting traffic. The car is loaded from bins under a high storage trestle at one end of the tunnel; it holds 30 cu. yd. of stone and has placed 201 cu. yd. of concrete in a day, at a rate, while operating, of a batch every 45½ sec.

The Carolina, Clinchfield & Ohio Rail-

road work after the completion of this particular job. The result of these studies was the determination to use the compressed-air method of mixing and placing the concrete, and to provide for this a plant to include a self-propelled concreting car, a loading and storage trestle, a compressed-air plant and pipe line through the tunnel, and concrete forms quickly and easily movable.

CONCRETING CAR DECIDED ON

On account of the great length of the tunnel it was deemed impracticable to furnish the concrete from a mixer located at



SELF-PROPELLED MIXING CAR CARRIES ITS OWN CONCRETE MATERIALS

way has recently completed and placed in operation that part of its line known as the Elkhorn Extension, from Dante, Va., to Elkhorn City, Ky., the terminus of the Big Sandy division of the Chesapeake & Ohio Railway. Where the extension passes under the divide known as "Sandy Ridge", just north of Dante, there is a tunnel 7804 ft. long, called the Sandy Ridge tunnel. This tunnel passes, for about one-half its length, through slate and shale formations which disintegrate upon exposure to air, and for the remaining half, through sandstone formation badly seamed and broken. In view of these conditions, the management decided to begin promptly the lining of the entire tunnel with concrete.

This work required the placing of between 50,000 and 60,000 cu. yd. of concrete, all of which had to be done while traffic was passing through the tunnel. In addition to Sandy Ridge there were a number of other tunnels on the above extension, as well as on other parts of the road, which might require lining in the future under similar conditions of traffic. With this in mind the railway engineers made a special study of various plans for the above work by which it could be done with economy and rapidity, also holding in mind that much of the plant would be used for simi-

either portal of the tunnel, as too much time would be consumed in transporting the wet concrete. It was concluded at the outset that the mixing could be done inside the tunnel where the concrete was to be deposited, and that a car carrying the ingredients would be the proper solution. It also appeared most desirable, if not absolutely necessary, to handle the car without filling the tunnel with smoke. These premises led to the idea of a self-propelled concreting car, and finally to the gasoline engine as most nearly fulfilling all conditions for the propelling device. A gas engine emits only a small amount of smoke or gas while moving, and can be shut off entirely when position has been taken. It occupies but small space and can be operated by one man. To obtain capacity, gravity flow of materials, and a convenient and desirable arrangement, the car was made as large as the standard clearance of the road would permit after allowing room for concrete forms. It is 40 ft. long over end sills, 10 ft. 4¼ in. wide over braces, and 17 ft. 9 in. high, from top of rail to top of car. It is built of steel, as the material bins are high above the rail and the weights considerable.

The car has a central chamber, open on the sides, 8½ ft. long, 9 ft. 8 in. wide and

10 ft. 3 in. high, in which is located on one side the pneumatic concrete mixer and on the other side the charging skip. Over this chamber is a water tank of 1850 gal. capacity. This tank furnishes water for the concrete and is also connected with the cooling system for the gasoline engine. Facing the central chamber is the stone bin of 30 cu. yd. capacity on one end, and the sand bin of 12 cu. yd. capacity on the other. Each bin has a chute 20 in. wide leading to the charging skip, and each chute is controlled by an under-cut gate. Under the stone bin is space occupied by a 96-cu. ft. air receiver standing vertically, and also a space for the storage of cement in bags, which is protected from water by the bin overhead. Under the sand bin are the gasoline engine and its auxiliary equipment, completely housed from water and dust. The charging skip in its lower position stands with its top rim about 15 in. above the floor, and it travels on inclined guide rails to its upper position over the mixer, being hoisted by a compressed-air cylinder of 9¼-in. diameter. The gate of the skip works automatically by means of a guide rail.

The mixer is for a two-bag batch (4/10 cu. yd.) and has its 8-in. outlet pipe at the bottom running horizontally and curving to the outside of the rear truck and thence vertically to near the top of the car, where it branches by means of a wye into two

lines, one a 180-deg. bend to the rear for "shooting" in the foundation and sidewall, and the other going to the roof for shooting into the arch. The wye is a special patented device with a sliding plate controlling the movement of material into either arm. The arrangement of the pipe, traveling with the car and being in position at all times for shooting concrete, is considered an important one in saving time and expense. One of the difficulties of many jobs where the pneumatic mixer has been used is the handling of the big heavy pipe.

Along one side of the car is a folding platform 2 ft. wide level with the main floor. This is used by the men carrying cement, and to get to and from the engine room. During the ordinary work of the car this platform remains down.

The entire arrangement is compact, and designed with a view of saving manual labor. One man controls the hoisting of the skip, injection of water and mixing and discharge of the batch. One man is placed at each chute and two men carry, open and empty the cement bags.

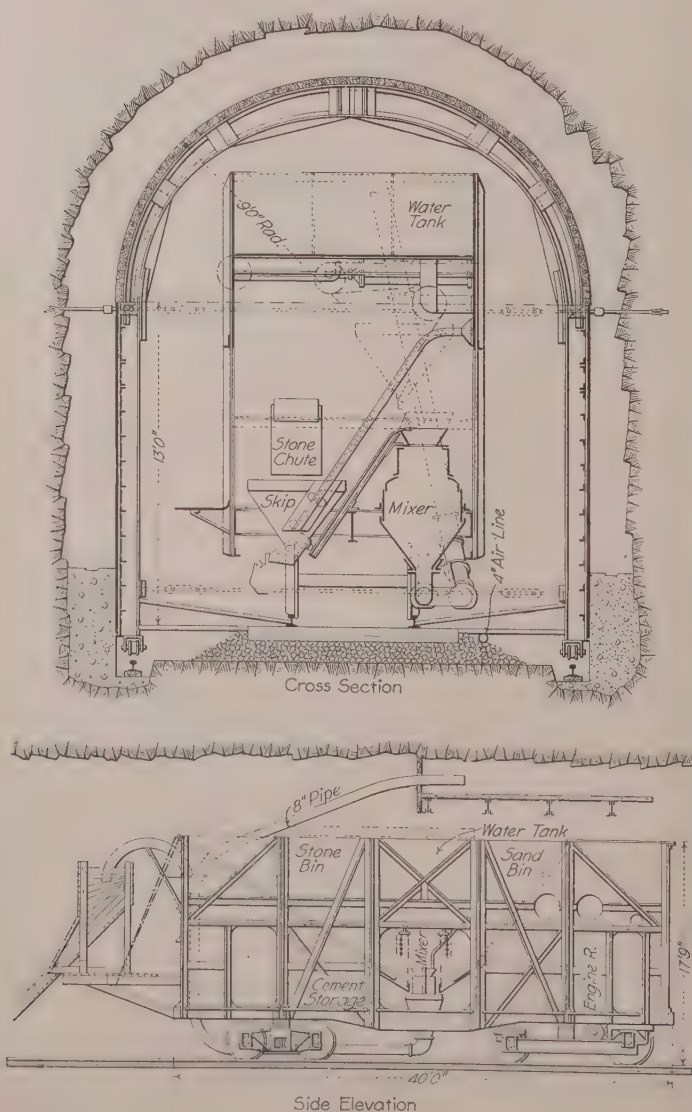
The gasoline engine is of the six-cylinder four-cycle T-head type, rated 200 hp. at 350 r.p.m. It can be throttled to 125 r.p.m. The motor and its frame constitute one of the trucks of the car. The cylinders stand in a row at right angles to the track and the whole construction is compact but ac-

cessible. The engine is started by compressed air being admitted to three cylinders, after which the explosion of the gasoline takes place in the other cylinders and continues the motion. The transmission is by means of a Morse chain on the driven axle, and the control is through a friction clutch of special design. The general principle employed is much the same as in the ordinary automobile.

The car and gasoline engine were built by the McKeen Motor Car Company, of Omaha. It was sent knocked down and was erected at the railway shops at Erwin, Tenn., whence it moved to the work, 105 miles distant, under its own power at a speed ranging at times as high as 25 miles per hour. The mixer was installed and the piping done on the car by the Pneumatic Placing Company, of New York City.

LOADING AND STORAGE TRESTLE

The loading trestle is of special design and is so arranged that the car goes under it and receives stone, sand, cement and water all by gravity and frequently all at the same time. The sand and stone are drawn from overhead bins by means of under-cut gates. Cement is conveyed into the car by a chute. The trestle has a track over its deck on which stone and sand in hopper cars are stored or unloaded into the bins below. There is a continuous row of twenty-seven bins with an aggregate ca-



PNEUMATIC MIXER DRAWS AIR FROM LINE IN TUNNEL



STORAGE TRESTLE CHARGES MIXING CAR BY GRAVITY

capacity of 324 cu. yd. and a total length of 162 ft. Five loaded cars can be stored over these bins, giving an additional storage of 200 cu. yd.

COMPRESSOR PLANT AND PIPE LINE

The compressor plant is exceptional for a temporary outfit. To save money on foundations and at the same time increase the space, the floor level of boilers and compressors was fixed 4½ ft. above subgrade and the concrete foundations and rim walls were built up to this height, the cellular space underneath being utilized for water tanks and ash pit. The building is of 1-in. boards covered with tar paper. The arrangement chosen permits coal to be dumped from cars on the trestle to a pile in front of the boilers. There are two boilers, both locomotive type, one new 150 hp. and one old 70 hp. Only two compressors are installed, but an extra foundation for another unit is provided. The compressors are of a high-speed, single-stage type, with a capacity of 375 cu. ft. of free air per minute each. They work under 125 lb. steam pressure and compress air to 115 lb.

From the compressor a 6-in. pipe leads to a 150-cu. ft. air receiver and thence a 4-in. pipe line goes on a steady 0.5-per cent down grade entirely through the tunnel. At the lower end is a pet cock to drain off any water. In order to care for expansion and contraction the pipe line is laid alternately on the east and west sides of the track in lengths of about 1000 ft. and connected by curves of 2-ft. radius. The bottom of the pipe is level with the bottom of the ties, 1 ft. from their ends. About every 100 ft. a long radius tee is placed, and about twenty mine cocks of 24 in. are provided, which can be shifted to the various tees as the progress of the work demands. To any of the mine cocks a 3-in. hose may be connected from the 96-cu. ft. air receiver on the car, and in this way with a hose 60 ft. long the car can be connected to the 4-in. pipe line at any point at which it may stop and receive an ample supply of air.

STEEL FORMS USED

The forms are of steel, with the exception of the arch ring, which is 3-in. hard pine on steel ribs. They are of the Blaw collapsible type, and of exceptionally stiff design. They are held by anchor bolts to the walls of the tunnel, and are without interior bracing, rods or struts, so that the concreting car as well as trains may pass without interruption. They are collapsed by means of turnbuckles on rods temporarily inserted as shown in the drawing. Five 30-ft. sections are provided, and it is expected that the car will fill at least one section each day and lose no time waiting for the moving of forms or for concrete to take its set. For the foundations and initial bench wall wooden forms are in use. They are made in 12-ft. sections and braced from the track.

The car began regular operation in the tunnel on July 9 and has worked every day

180 cu. yd. per day and one run of 201 cu. yd. have been made. The work so far has been putting in the foundation and initial lift of bench wall 4 ft. 4 in. high, which requires moving the car more often than will be necessary when shooting into the arch form begins. The performance is, however, largely dependent on interference from trains passing through the tunnel.

One other feature of the plant is the short pipe through which the charge moves. Generally speaking it has been held that at least 50 ft. of pipe was necessary to get a good mixture of concrete. In this case it goes through 41 ft. of pipe and 10 ft. of chute, and the mixture is good. In several installations concrete has been placed through 1200 ft. of pipe and the record for distance to date is believed to be 2805 ft.

One of the difficult problems confronting the designer is to place the charges of ingredients into the mixer fast enough to work it to its capacity. The mixer can shoot a batch every 15 sec. provided sufficient air is furnished, but to give it a charge of material every 15 sec. seems to be an unsolved problem.

Time records of the plant given in Table 2 show the speed at which batches are discharged, giving the actual time the car is coupled to the hose and working inside the tunnel. The variation is due to condition of material, whether wet or dry, which

TABLE 2—RATE OF DISCHARGE OF BATCHES

Date	Batches	Minutes	Average, Sec. Per Batch
Aug. 17.....	423	381	54.0
Aug. 18.....	323	302	56.1
Aug. 19.....	448	340	45.5
Aug. 20.....	325	250	46.1
Aug. 21.....	309	280	54.3

affects the rapidity with which it flows in chutes and skip. It is believed that the operation can be speeded up to an average of 35 or 40 sec. with dry material. The door of the skip automatically opens as the skip reaches the charging position and closes as it is lowered away from it, the door serving as a chute while open. Also, the side slopes are steep and unbroken, so that the skip can free itself quickly.

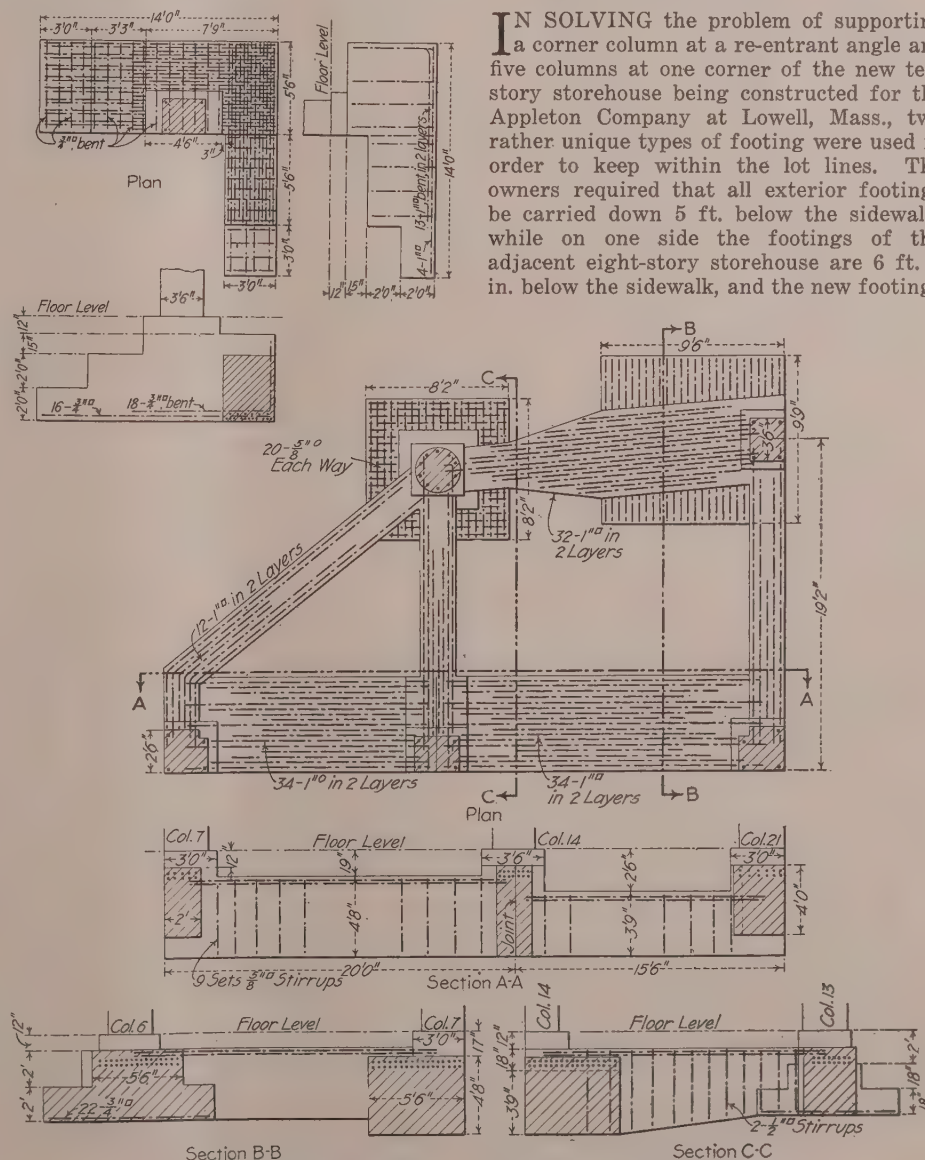
The lighting of the inside of the car is by carbide lights and of the outside work by hand torches and carbide lights.

The plant was designed by O. K. Morgan, office engineer of the Carolina, Clinchfield & Ohio Railway, under the general direction of Ward Crosby, chief engineer.

Reinforced-Concrete Footings of Special Construction

Outside Corner Columns for Ten-Story Storehouse Supported on Low-Bearing Soil Without Extending Beyond the Lot Line

IN SOLVING the problem of supporting a corner column at a re-entrant angle and five columns at one corner of the new ten-story storehouse being constructed for the Appleton Company at Lowell, Mass., two rather unique types of footing were used in order to keep within the lot lines. The owners required that all exterior footings be carried down 5 ft. below the sidewalk, while on one side the footings of the adjacent eight-story storehouse are 6 ft. 3 in. below the sidewalk, and the new footings



PLANS AND SECTIONS OF REINFORCED-CONCRETE FOOTINGS OF SPECIAL DESIGN

TABLE 1—CONSTANTLY INCREASING WEEKLY YARDAGE

Week Ended—	Yardage	Yardage
July 17.....	261	
July 24.....	379	
July 31.....	516	
Aug. 7.....	822	
Aug. 14.....	928	

since, Sundays excepted. It has steadily increased its output as the men became more used to the work and better organized, as is shown by Table 1. Several runs of

had to be carried to the same depth. The solution of this problem (for the most interesting cases) is shown by the plans and sections herewith.

The building is designed for floor loads of 150 lb.; the story heights are 8 ft. except for the first floor, which is 13 ft. 3 in. high. All footings are designed for a soil pressure of 8000 lb. per square foot, and in accordance with the report of test results in the Bulletin of the University of Illinois. The unit stresses used are those recommended by the Joint Committee.

FOOTING AT RE-ENTRANT ANGLE

The unusual angle-shaped footing for the corner column was chosen because of its greater economy. The center of gravity of the footing is under the center of the column. The cantilever stresses at the projecting ends are provided for by the bending

New Steel and Concrete Structure to Furnish Nearly Sixteen Acres of Floor Space

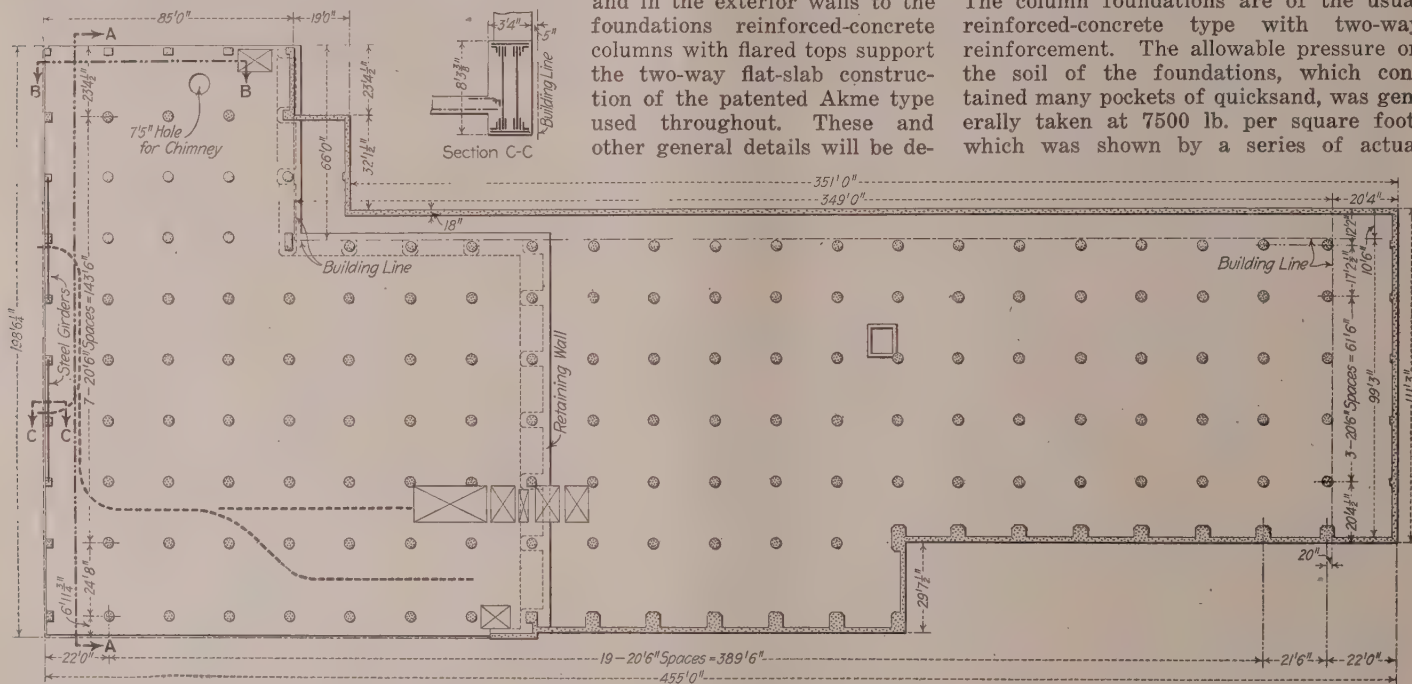
Bingham Warehouse in Cleveland Designed for Heavy Floor Loads—Steel and Reinforced-Concrete Columns Support Flat-Slab Floors

THERE is now under construction in Cleveland a large steel and concrete warehouse for the William Bingham Company, which is to furnish nearly 16 acres of floor space. Unusually heavy columns and floor slabs are required in the 8-story structure to support the specified live loads on typical floors of 500 and 300 lb. per square foot. All the interior columns up to the second floor level and the four exterior columns under steel girders were made with heavy steel cores. Above the second floor in the interior of the building and in the exterior walls to the foundations reinforced-concrete columns with flared tops support the two-way flat-slab construction of the patented Akme type used throughout. These and other general details will be de-

shown on section AA in the drawing, was provided to allow the storage of long bars in special racks to be installed on this floor.

The difference in elevation of about 25 ft. between front and rear column footings made it necessary to drive and shore heavy steel piling across the site and build the slab-and-pier wall as a free standing wall with the steel sheet piling left in place.

The steel stack with brick lining shown in the section is entirely independent of the building and is supported on a brick pier. The column foundations are of the usual reinforced-concrete type with two-way reinforcement. The allowable pressure on the soil of the foundations, which contained many pockets of quicksand, was generally taken at 7500 lb. per square foot, which was shown by a series of actual



GENERAL PLAN OF BINGHAM WAREHOUSE—HEAVY STEEL GIRDERS IN REAR OVER ENTRANCES FOR OVERHEAD TROLLEY

up of the tension steel and liberal reinforcement for shear.

The other footing, designed to carry five columns as shown, is also arranged to bring the center of gravity of the total upward and downward forces vertically in line with each other. The long beam shown in elevation at section AA is designed as two simple beams, with the joint at column 14 as indicated. These straps are therefore all designed as simple beams with uniform loading.

These data have been furnished by E. F. Rockwood, chief engineer of the New England Construction Company, of Boston, contractors for the building.

THE ASHOKAN RESERVOIR basin of New York City's new water supply was cleared and grubbed during 1914 at a total cost of \$383,472.90. A total of 10,377 acres was cleared, 1870 acres grubbed and 1022 cu. yd. of material excavated. A strip of 5 ft. above and 15 ft. below the future shore line of the reservoir was grubbed, and two low dikes were built to flood a large part of the reservoir floor in order to reduce the amount of second growth to be cut before the reservoir was finally flooded.

scribed, including the heavy 41-ft. steel girders supporting 500-ton loads at their midpoints where reinforced-concrete columns carry the upper floors.

GENERAL DIMENSIONS AND CONSTRUCTION

The typical floor of this warehouse contains about 57,000 sq. ft. and is entirely free from partition walls. As seen on the plan view of the second basement here shown, the front width between building lines is about 99 ft. and the rear width 198½ ft., while the total length is 435 ft. between building lines, or 455 ft. between basement walls, the first and second basements extending 20 ft. under the sidewalk in front. A total of 15.7 acres of floor space is thus provided by the eight upper floors and three basement floors of the building. The height is about 101 ft. above the sidewalk of Ninth Street in front, and 148 ft. above the tracks in the rear, the various story heights being given on the sections shown in the drawings. The third basement floor extends only eight bays from the rear of the building, where a heavily reinforced slab-and-pier retaining wall about 28 ft. high is built. The unusual height of 25 ft. from third basement floor to second basement floor, as

tests to be a conservative bearing value for the soil. At the northeast corner, where a stratum containing many quicksand pockets was found, steel piling cofferdams were driven and the footings carried down to a firm foundation. Design loads and unit stresses for the steel and concrete conform to the requirements of the Cleveland building code.

STEEL COLUMNS AND HEAVY GIRDERS

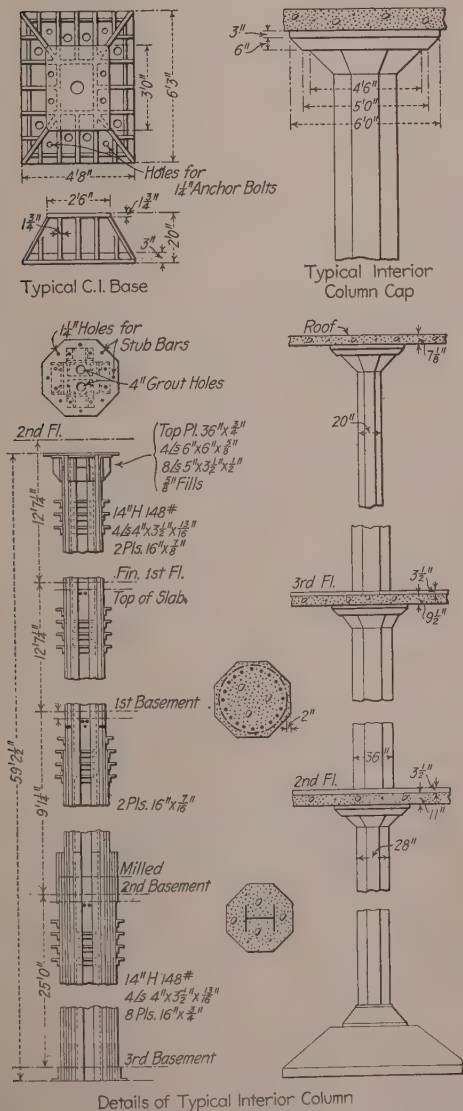
Although most of the columns are of reinforced-concrete, either octagonal with spiral reinforcement, or square with longitudinal rods, the 59-ft. columns in the rear from the foundations to the second floor are designed with steel cores and octagonal concrete fireproofing. The heavy loads on these columns, sometimes exceeding 2000 tons, were assumed to be carried by the steel, the allowable unit stress averaging about 13,200 lb. per square inch, except that 1/16 of the live load was assumed to be taken by the concrete inclosed by the four angles, as allowed by the Cleveland code. The accompanying detail drawing of a typical interior column indicates the manner in which the section is varied by the addition of 16-in. side plates to the main H-section and four angles. The 3 x 3-in.

shelf angles below each floor line are for the purpose of transmitting the heavy floor loads to the steel shaft of the column. A typical heavy cast-iron column base is also shown in detail on this drawing.

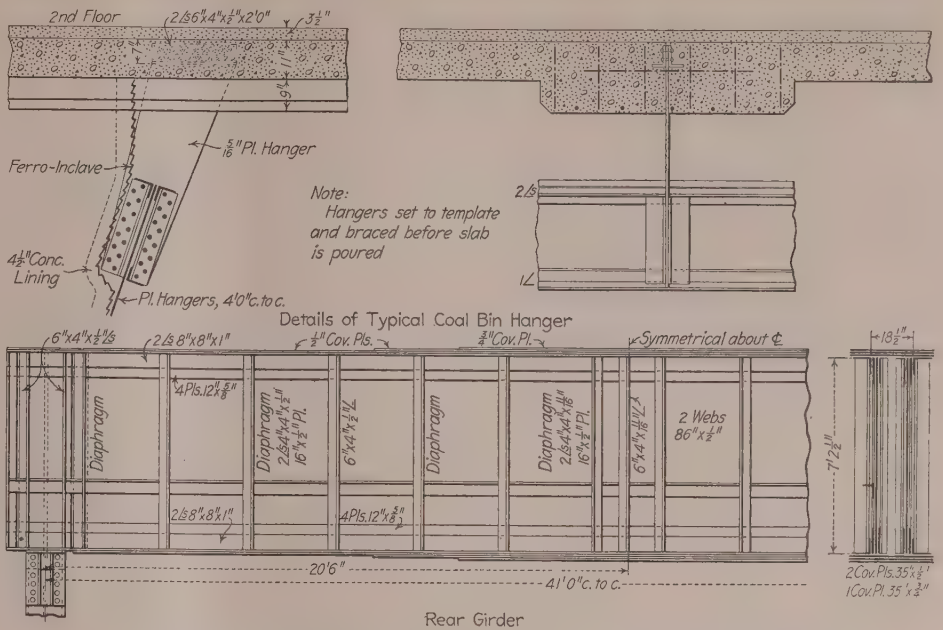
In the rear of the building at the second basement floor two heavy steel girders of 41-ft. span were required to support the columns above. In order to allow the installation of a 5-ton overhead trolley in the third basement, as shown in the plan view by heavy dash lines, with two outlets to the track in the rear and large unobstructed openings for material, the omission of two columns in this basement was necessary. The loads carried by the upper sections of these rear columns are more than 1,000,000 lb. each, hence the necessity for providing the heavy 30-ton girders whose sections are shown on the drawing. These two web-girders are riveted to the flanges on the H-columns which support them, are securely tied together with the diaphragms shown, are entirely covered with concrete as indicated by the section AA of the plan drawing, and support heavy square reinforced-concrete columns at their midpoints.

TYPICAL COLUMN AND FLOOR CONSTRUCTION

The reinforced-concrete columns are mainly octagonal in form with spiral reinforcement and are flared out at each floor as shown on the accompanying elevation and section above the second floor, with



COLUMN DETAILS AND CAST-IRON BASES



DETAILS OF COAL-BIN HANGER AND HEAVY STEEL REAR GIRDERS

typical cap dimensions of an interior column indicated. The floor is the patented Akme type, with two-way reinforcement. The typical thickness for these bags which are 20 1/2 ft. square, are 11 in. for the live load of 500 lb. per square foot for first floor and the basement floors and 9 1/2 in. for the 300-lb. live load from the third to the eighth floors inclusive.

The building contains several special features. A spiral package chute is provided, and pneumatic tubes are installed in the elevator shafts. The coal conveyor system from the coal receiving hopper to the 95-ton bins below the second floor is indicated on the section, and makes possible a very efficient handling of the coal for the boilers. Equally efficient is the method adopted for the disposal of ashes by storing in the hopper shown, and then chuting to cars by the chutes indicated on the sections.

HANGERS FOR BINS

One of the drawings shows the details of the special steel hangers set into the concrete for supporting the coal and ash bins. These supports and bins were designed for coal assumed to weigh 50 lb.

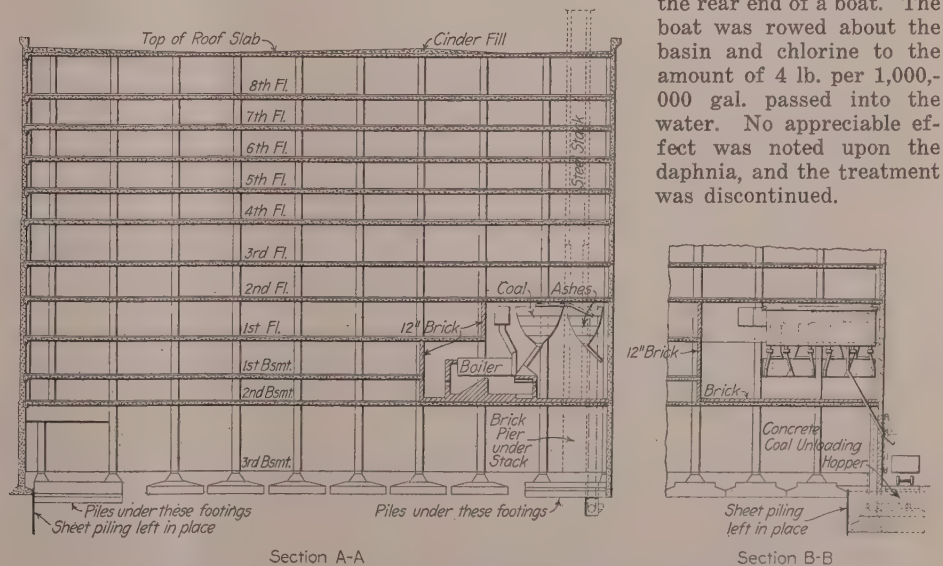
per square foot, and ashes 65 lb. per square foot. The usual allowable stresses were used for the steel and the allowable bearing value of steel on concrete was taken at 400 lb. per square inch.

The entire facing of this building is of paving-brick seconds, and all windows are of steel sash and wire glass. About 300 tons of cast iron for the column bases, 1200 tons of structural steel and 2300 tons of reinforcing rods will be required. About 38,000 yd. of concrete will be used, and the total cost will be about \$1,000,000.

The architects for the building are Walker & Weeks of Cleveland. The design was made by Christian, Schwanzenberg & Gaede, engineers, representing the Akme system, and approved by T. J. Bryson, engineer for the architects. The general contractor is the Crowell-Lundoff-Little Company of Cleveland, and the structural steel is furnished by the McClintic-Marshall Company of Pittsburgh.

WATER FLEAS IN A ST. LOUIS RESERVOIR were not killed by the liquid chlorine applied to one of the basins. An iron pipe extending to within 1 ft. of the bottom was attached to a cylinder of chlorine placed in

the rear end of a boat. The boat was rowed about the basin and chlorine to the amount of 4 lb. per 1,000,000 gal. passed into the water. No appreciable effect was noted upon the daphnia, and the treatment was discontinued.



SECTIONS SHOWING COAL AND ASH HANDLING ARRANGEMENT

Wicket Gates the Logical Development for Hydraulic Turbine Regulation

Careful Study of Efficiency in Commercial Operations, Freedom from Eddies and Corrosion and Other Advantages Sustain American Practice

By LEWIS F. MOODY

Professor of Hydraulics, Rensselaer Polytechnic Institute, Troy, New York
Consulting Engineer, Hydraulic Department, I. P. Morris Company, Philadelphia

TWO ARTICLES which have appeared recently in the Engineering Record—the first entitled “Cylinder Gates Increase Turbine Efficiency,” by A. G. Hillberg, in the issue of April 17, page 485, the second entitled “Do Cylinder Gates Increase Turbine Efficiency?” by H. Birchard Taylor, in that of May 29, page 690—have introduced a subject of much interest to all concerned with the development of hydraulic turbines. The discussion by Mr. Hillberg appended to Mr. Taylor's article has seemed to the writer to introduce a number of points which call for further consideration. In fact the whole subject is one of such importance that it does not deserve to remain in the indeterminate state in which this discussion appears to have left it. It is especially important to avoid misconceptions which may arise in the minds of engineers who are not fully in touch with the highly specialized branch of engineering which is concerned with waterwheel design, and such misconception is likely to arise due to the complete disagreement between the conclusions reached by the two authors mentioned.

EVOLUTION OF THE MODERN TURBINE

The modern hydraulic turbine is the product of gradual development during a large number of years, but a large part of the progress has been concentrated into a period extending back not more than about ten years. Fifty years or more ago turbines of all kinds were in use, both the so-called reaction and impulse types being used for ordinary heads, and inward, outward and axial-flow runners being employed. And the methods of regulating the turbines were as much varied as the types of turbines in use. Turbines of both the partial flow and the complete admission types were employed. In the struggle for existence a majority of the types failed to survive and the field became narrowed to a few arrangements.

At the time the first large Niagara plant was planned the field for large units had become narrowed down to the complete-admission “reaction” turbine of either the inward, outward or axial-flow type. The course of development then rapidly eliminated both the outward flow and axial types, leaving the inward-flow turbine as the sole survivor. This form had been advocated many years before by James B. Francis, the American hydraulic engineer, who showed that it had possibilities of higher efficiency than the outward-flow type. It is doubtful, however, whether this form of turbine would have survived rather than the axial-flow or “Jonval” type if there had not been another important consideration affecting the question. This consideration was the method of regulation or control which could be used.

CONTROL OF TURBINE OUTPUT

In order to control the power output of the turbine a few of the methods which have been used at various times are as follows:

In the early impulse turbines, which were

of the outward-flow “Girard” type with partial admission, rotating gates were placed between the guides and runner which cut off successively the openings between the guide vanes, these gates operating by a circumferential motion. The evolution of the impulse turbine has witnessed the complete abandonment of these cylindrical gates, the modern impulse wheel being of the tangential type regulated by needle nozzle.

The early reaction turbines of the outward-flow or “Fourneyron” type were usually regulated by cylinder gates moving axially across the discharge space of the runner. The axial-flow or Jonval turbine



FIG. 1—REGISTER GATES PARTLY ROTATED

was the most difficult of all types to regulate in any efficient manner. The usual methods used were the use of rotating gates or a flexible covering which moved circumferentially and closed off the entrance of the guide passages one by one. This method of regulation caused a turbine which at full gate would have complete admission all the way around the runner to operate at part gate with “partial admission”, meaning that water was admitted only part way around the circumference. These methods of regulation, which were available with the Jonval turbine, were entirely unsuited to the requirements of close-speed regulation which were demanded when the modern use of turbines for driving electric generators came into being.

THREE TYPES OF GATES

The inward-flow turbine, or the “Francis” turbine, as it has been named, can be regulated by the following methods:

1. The register gate, which may be described as a division of the guide vanes into two concentric rings, one within the other, either the inner or outer ring being movable circumferentially to fill the openings between the vanes in the other row. (See Fig. 1.)

2. The cylinder gate, which is a cylinder capable of moving across the space between the guides and the runner. In some turbines this gate was made to enter this space from the draft-tube side, but general practice favored its being placed on the crown side of the runner. (Fig. 2.)

3. The pivoted guide vane or wicket-gate arrangement which was formerly known in Germany as the “Fink” method. This method was adopted in some of the early

American turbines and has come more and more into use, until to-day it is by far the most approved method.

All three of these methods were greatly superior from a mechanical point of view to those used with the Jonval turbine, and also gave superior efficiency for partially open positions of the gates. These considerations, the writer believes, are responsible in a large measure for the general adoption of the inward-flow reaction turbine at the present time as the surviving type. It is true that the Jonval turbine can be regulated by movable guide vanes similar to the ordinary wicket gates, but this arrangement involves complexities of design and manufacture and is mechanically inferior. The trend toward extremely high speeds in turbines of great unit capacity; that is, toward high “specific speeds,” has caused a distortion of the inward-flow turbine until it has approached more and more the axial-flow type, and the modern runner of extremely high-speed departs widely from the simple inward-flow type. If it were not for the advantage of inward flow as affecting regulation the high-speed runner would probably approach the Jonval design more nearly than it would the simple Francis runner.

REGISTER GATES

In comparing the three methods of regulation, the register gate is mechanically simple, but it is so injurious to efficiency when partly closed that it must be discarded except in rare cases. The register gate is also subject to a heavy hydraulic load when partly closed and requires a considerable amount of power to operate it. When the register gate is partly rotated (see Fig. 1) the openings between the successive guide vanes are reduced so that the quantity of water is diminished; but at the same time, since the inner ends of the guide vanes stand at the same angle, this quantity of water is insufficient to fill the space between the vanes, and a large part of the passages becomes filled with eddies. This formation of eddies has two serious objections. The first is the resulting loss of head, and the second the great probability of dangerous erosion being caused, which is a vital defect. The formation of these eddies behind the guide vanes can be avoided by reducing the angle at which the vanes are inclined, thus cutting down the space through which the water is admitted, but at the same time allowing the water to enter the runner in a solid body of revolving water, so that even at small gate openings the water enters the runner with smooth flow and very little turbulence. This leads

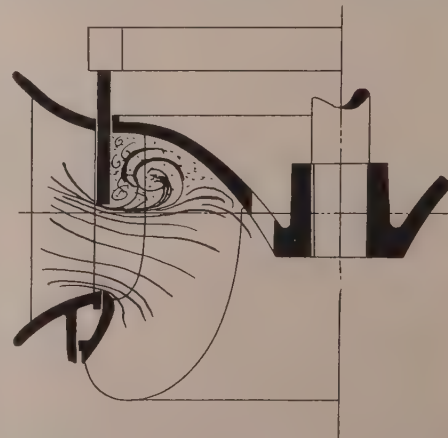


FIG. 2—CYLINDER GATE WITHOUT THE PROJECTING LIP

us logically to the wicket gate, in which the vane angle is changed to suit the quantity of water flowing.

Another unfavorable condition accompanying the use of register gates, and encountered in still greater degree in "partial-admission" turbines, is the variation in the flow through any given runner bucket from instant to instant as the bucket entrance passes from smoothly flowing to turbulent water and back again. The varying conditions thus caused set up surges in the buckets and promote vibration and unstable operation.

CYLINDER GATES

The cylinder gate, while requiring less power for its operation than the register gate, is somewhat similar to the latter in that it couples with the reduction of the space through which the water is admitted the introduction of a space behind the gate filled with eddies and turbulent water. Instead of the turbulent condition existing in a series of spaces corresponding to each guide vane, with the cylinder gate the whole volume of water behind the gate is filled with eddies (see Fig. 2) in a manner similar to the space behind a board which is moved in a direction perpendicular to its plane through still water. The existence of this condition is shown not only by the low efficiencies obtained when the gate is partly closed, but also by the rapid erosion or corrosion of the portion of the runner back of the gate. This corrosion has in some cases been experienced even under low head; and when the head is moderately high the deterioration becomes so rapid that this type of gate is strongly condemned on this ground alone.

Attempts have been made to improve the efficiency obtained with cylinder gates by adding projecting lips outside the lower edge, as shown in Fig. 3. This addition has been thought to give a slight improvement; but such a change cannot eliminate the eddy-filled space behind the gate.

WICKET GATES

The action of the wicket gate, while permitting the water to enter the runner in a solid body as mentioned, also involves, to a certain extent, the formation of eddies after the water has entered the runner. This is due to the fact that when the direction of the entering water considered with respect to the rotating runner becomes inclined at a considerable angle to the direction of the runner vanes, spaces are left on one side or the other of the runner vanes which must be filled with eddies. Owing to the fact, however, that the runner vanes converge toward their discharge ends so

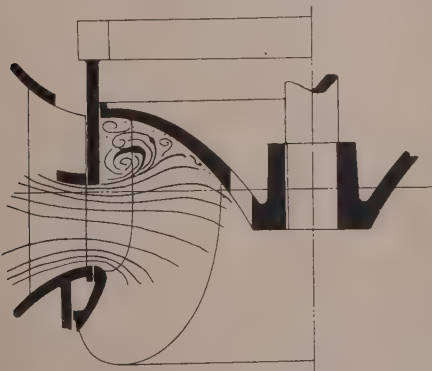


FIG. 3—CYLINDER GATE PROVIDED WITH THE PROJECTING LIP

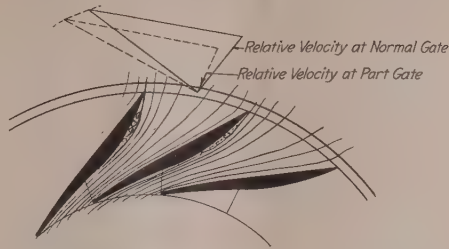


FIG. 4—DIRECTIONS OF FLOW, WICKET GATE

that the narrowest opening is at discharge, the water column is again brought in contact with both adjacent vanes, and at all moderate gate openings the water must fill the runner buckets at discharge. The loss due to this slight tendency to eddy formation remains small over a wide range of gate movement.

The greatest loss in efficiency caused by wicket gates when partly closed is probably due to the fact that the water no longer leaves the runner in a direction normal to the motion of the runner, so that a large discharge loss due to the resulting whirl in the draft tube is produced. The latter loss, however, is produced to an equal extent if either register or cylinder gates are used, since in all these cases the outflow area of the runner buckets retains its full value and is not adjusted to conform to the variation in the guide-bucket area.

DIRECTION OF FLOW

Mr. Hillberg has noted an interesting theoretical point in comparing wicket and cylinder gates. In his discussion of Mr. Taylor's paper he states that "a stream of water fed to a turbine through wicket gates has different directions at different gate openings. In designing the gates and the runner it is customary to give the direction of flow the most advantageous angle at 0.8 gate. When a cylinder gate is employed the guide vanes direct the flow of the water at a constant angle for all gate openings, which naturally tends to increase the efficiency." This same view has been given in several books on hydraulics.

It is perfectly true that with the cylinder gate the absolute direction of flow of the entering water remains the same at all gate openings, while with wicket gates the absolute direction changes as the gates are rotated. In considering the effect upon the runner of the direction of the water, however, it should be remembered that it is the motion considered relatively to the rotating runner which must be taken into account, and not the absolute motion or motion with respect to the earth. When the turbine gates of either the cylinder or wicket type are partly closed the area through the gates is reduced, while the discharge area of the runner remains the same, as noted above. The effect of this is to permit the water flowing through the guide-vane orifices to reach higher velocities as the gates are closed (in the same way that the velocity through a valve in a pipe is increased when the valve is partly closed.) Referring to Figs. 4 and 5 it will be seen that whether the direction of the absolute velocity is constant or varied the magnitude of the absolute velocity will be changed, so that the relative direction of entrance of the water into the runner is changed in either case. Thus the formation of eddies within the runner is not confined to the wicket gate but also exists with the cylinder gate. In the latter case, however, the eddies due to

this cause are added to the large disturbance immediately behind the gate, described above.

EFFICIENCIES AT PART GATE

From the above considerations it seems clear that we must look for a much more rapid decrease in efficiency when a cylinder gate is operated than would be caused by wicket gates. That this theoretical conclusion is in agreement with actual experience has been proved many times by turbine tests. The typical efficiency curve obtained from a cylinder-gate turbine shows that as the power is reduced the efficiency falls off almost in direct proportion, the curve being but little above a straight line.

The tests quoted by Mr. Hillberg appeared to upset this generally accepted conclusion, as indicated by the title of the first article. An analysis of the tests on which the article was based, however, shows that on the basis of these tests themselves, the exact reverse of the conclusion noted is unquestionably the fact.

The fallacy of Mr. Hillberg's conclusion arose from the fact that as the cylinder gate is closed a relatively large amount of motion is required to produce a small reduction in power below that at full gate. When the cylinder gate approaches the closed posi-

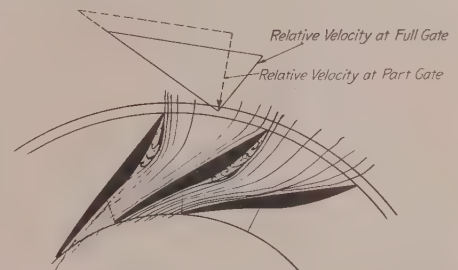


FIG. 5—DIRECTIONS OF FLOW, CYLINDER GATE

tion the rate of reduction in power becomes much more rapid, a curve of horsepower versus gate movement being decidedly convex. With wicket gates the same curve is very nearly straight up to the wide open position of the gate, when it bends over as shown in Fig. 6. While these considerations have some bearing on the action of the turbine governor, they are of no importance in connection with the turbine performance.

VALUES IN COMMERCIAL OPERATION

In considering the value of the turbine in commercial operation, the curve showing the different efficiencies which may be obtained at different rates of output; that is, at different values of the horsepower, should be compared, without reference to the particular gate openings which are required to give these outputs.

It has been customary for some engineers, in specifying the desired turbine performance for new plants, to call for guarantees of efficiency at certain gate openings. This practice is likely to lead to confusion. The performance of a turbine should be judged only with respect to the efficiency which can be obtained at given loads; that is, the performance curve which is significant is a curve plotted between efficiency and delivered horsepower such as that given in Mr. Taylor's article for the same data as the curves mentioned above. An examination of the efficiency-horsepower curves for these data shows that the wheel having the cylinder gate gave its highest efficiency when the gate was fully withdrawn, and

that as soon as the gate was advanced even a small amount across the water passage the efficiency immediately began to drop. Therefore, it is clear that the only condition under which the cylinder gate can give good efficiency is when it is absent.

In the majority of hydraulic power stations it is desired to have the maximum turbine efficiency occur at between 80 and 90 per cent of the full load on the unit, so that for normal operation the unit can be run at or near its point of best efficiency, a margin in power being left above this point to carry the ordinary fluctuations of load experienced. This important characteristic cannot be obtained efficiently with the cylinder gate, because if the wheel is designed to give its best efficiency when the cylinder is not fully withdrawn, this efficiency will be impaired by the partial obstruction from the gate. The comparison of performance of the two turbines, the tests of which form the basis for these articles, would be still more striking if the runner had shown better part-gate efficiencies, and if the guide vanes used in the wicket-gate tests had been of such design as to permit the runner to develop its maximum efficiency. Thus the efficiency at half load is seen to be less than 75 per cent with the wicket gate and less than 70 per cent with the cylinder gate, both of which figures are considerably below the best results which have been obtained in other wheels of the same specific speed.

COMPARISON OF GATE MECHANISM

Referring briefly to some of the other points under discussion, the writer believes that a comparison between the mechanism used for operating the wicket gates in the most modern designs of turbines, with the operating mechanism required to handle cylinder gates in large units, will upset the idea which used to be accepted, that the mechanical operation of cylinder gates is superior to that of wicket gates. The writer believes the exact reverse to be true. The mechanism necessary for operating cylinder gates in large units is quite heavy and cumbersome, since the longitudinal motion of the gate must be received through several draw rods which must be connected by a heavy frame and guided so that they will have identical motions, in order to avoid any possible tilting of the gate. This mechanism, while capable of being counter-balanced to carry the weight of the gate, still involves a large amount of inertia which must be overcome when quick action is required of the governor.

Wicket-gate mechanism as now designed is extremely satisfactory from a mechanical standpoint. The small angular motion of the gates is accompanied by slight inertia effects and may be accomplished rapidly. It is true the gates are not balanced in all positions, and it is not desirable that they should be balanced. When properly designed the gates become hydraulically balanced at a small gate opening. When the unit is running at wider gate openings, a breakage of the operating gear would be followed by the automatic closing of the vanes to their balanced position, thus throwing the load off the unit and at the same time avoiding the complete closure of the vanes, an action which involves danger from water hammer.

Cylinder gates in the majority of cases are also not free from hydraulic load. Heavy hydraulic loads are particularly difficult to avoid when projecting lips are used.

In regard to the risk of damage to gates

from trash lodging in them, the writer sees little to choose between the two forms. Movable guide vanes of large modern units are of such substantial design that little damage from this cause may be anticipated. It is possible in most cases to design the mechanism so that if an obstruction between two vanes should cause the entire governor power to be concentrated on these two vanes, breakage would still not be caused; and in all cases it is possible to design the links which turn the vane cranks so that these links will fail in tension before any other part of the vanes or mechanism will be damaged, the links being readily replaceable. An obstruction under a cylinder gate may sometimes produce a cocking of the gate which will cause it to jam, although this danger can also probably be avoided by heavy construction. Wicket gates have a decided advantage from the fact that their motion may be used to free them of trash.

ICE DIFFICULTIES

In connection with clogging by ice there is no reason why wicket gates should experience any greater difficulties than cylinder gates, and in fact it is possible to clear them of ice by opening them in a way which cannot be done when a cylinder gate is used.

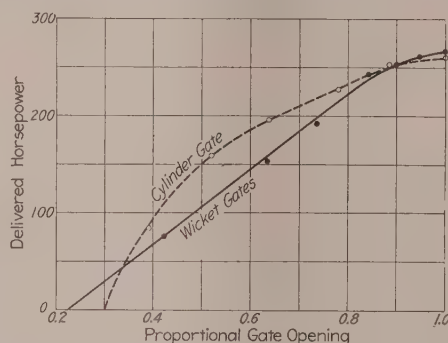


FIG. 6—COMPARATIVE HORSEPOWER AT VARIOUS GATE OPENINGS

It is, of course, possible for any turbine to be completely blocked with ice, but it is difficult to see why wicket-gate turbines should be more liable to clogging than those equipped with cylinder gates.

With reference to the experience at the Holtwood plant mentioned by Mr. Hillberg, I quote from the article of F. A. Allner, general superintendent of the Pennsylvania Water & Power Company, in the *Engineering Record* of July 24, page 115:

"Jan. 5, 1912.—No clogging up of the guide vanes on main units was observed on this occasion, and the disturbance to service was due to two causes, (1) the clogging up of the intake screens while proper facilities for removing them quickly were not available at that time; (2) the clogging of the runners (not guide vanes) in two small turbine-driven exciters after the removal of the screens. A motor generator exciter was at that time in process of installation but not yet available for service. Since then the alternating-current driven exciter and the installation of an excitation storage battery of ample capacity has removed the danger from this source completely.

"Feb. 14, 1914.—The reduced station capacity on this occasion was again due to the clogging up of the screens. Although slight adhesion of ice occurred at the guide vanes, one is inclined to ascribe this to the fact that the operator permitted his water level in the pit to drop below the intake

of the upper runner, the cold air then chilling the machinery parts around the intake excessively. With the wheel-pit gages mounted on the floor and the precautions given in our standard instructions for handling such trouble, there should be, in future, no difficulty whatever in the wheel pits being kept filled.

"Jan. 30, 1915.—This is an occasion when the ice conditions were severe, but due to the methods of handling ice menace as developed from previous experiences, no interference to service resulted, though one main unit (No. 5) had its guide vanes (and probably also its runners) well clogged up, while the turbine-driven exciters suffered, at intervals, slight reductions in capacity. The waterwheel exciters were easily kept sufficiently clear with the assistance of steam. It could not be stated definitely whether any ice formed in the runners or about the guide vanes of these exciter wheels, because it was not necessary to inspect the exciter pits during the ice run. From previous observations, however, one is inclined to ascribe the occasional reduction of the exciter output to the formation of ice in the runner.

"The fact that ice clogged up the guide vanes of main unit 5 is ascribed to the extremely severe conditions during this ice attack, and it is believed that probably any other type of turbine gate mechanism may have met with the same fate. On the other hand, it is believed that the movable-vane type of mechanism assisted materially on this occasion in clearing the water passages, for after a short application of steam had rotted the ice the latter was easily broken up and cleared out by moving the guide vanes.

"The practice of keeping the guide vanes steadily in motion during ice trouble probably helps a great deal to keep the openings clear. In the case of unit 5 on Jan. 30, it is believed that the moving of the vanes was not attended to properly by the operator during the initial stages of the ice run."

CONCLUSIONS

It would seem a safe rule that cylinder gates should never be used except for extremely low heads, perhaps not more than 20 ft., on account of the great danger of corrosion; and that they should never be used when the water available for the plant must be conserved.

Whether the turbines installed by the Niagara Falls Power Company to replace their initial installation should be cited as fairly representing modern practice is decidedly open to question. To the knowledge of the writer no results of efficiency tests on these turbines have ever been published, nor is information available regarding the rate of deterioration of the runners. On account of local restrictions which governed the design, and for other reasons, the design of these turbines is hardly like to be copied in other plants.

In conclusion, it is believed that the line of evolution of turbine design in America has been in the direction of progress and improvement, and that the prevailing use of the wicket gate is a logical development and is fully justified by results.

THE UNITED STATES PRODUCED 66.36 per cent of the 400,483,489 barrels of petroleum that entered the markets of the world in 1914, according to statistics compiled under the supervision of J. D. Northrop of the United States Geological Survey.

Practical Suggestions Given for Building Wire Fences and Concrete Posts

Experiences in Inclosing Catskill Aqueduct Right-of-Way Cited by
Ralph N. Wheeler, Department Engineer, Board of Water Supply

MANY miles of wire fencing on concrete posts have been erected during the last 3 yr. to define lines of property taken for the Catskill Aqueduct, and to mark rights-of-way and road crossings, all the work being done by contract. In the following paper, presented at the convention of the New England Waterworks Association in New York City last week, Ralph N. Wheeler, department engineer of the Board of Water Supply, explained in detail the methods of doing this work, giving many practical suggestions based upon the fence-building experiences on the aqueduct.

TWO CROSS-SECTIONS USED

Several cross-sections were used for posts, all reinforced, the posts generally tapering toward the top. For the so-called line post the T-section, reinforced with three No. 5 gage wire rods, was generally used, but on some parts of the work a D-section reinforced by four similar wires was preferred. D-posts being built under an existing contract have four $\frac{1}{4}$ -in. twisted rods. The line posts were generally 7 ft. 3 in. long, and are made to set $2\frac{1}{2}$ to 3 ft. in earth and not less than $1\frac{1}{3}$ ft. in rock. For straining, gate and latch posts, the square cross-section was used, reinforced with four $\frac{1}{4}$ or $\frac{1}{2}$ -in. square twisted rods, depending on the length of the post. No ornamental tops were used, the only attempt at ornamentation being to provide pyramid tops for hinge and latch posts.

TABLE METHOD OF CASTING

All posts were cast in thin sheet-metal forms in horizontal position. The D or T-sections were assembled by the battery or the table methods, the former grouping comprising a small steel car with hinged ends, so designed as to permit the placing and filling of five layers of six molds each, and the latter consisting of a skeleton table on which the molds were placed. Both methods provide for tightly closing the ends of the molds. Preference is expressed for the table method, as the faces of posts are exposed for troweling or rubbing at the proper time; slightly more floor area is, however, required. Objections to the battery method are the drip from the upper layers, which tends to pit the faces below, and the impracticability of troweling or rubbing the faces. Jogging, essential for properly expelling the air, is accomplished by shaking the skeleton table or moving the battery car back and forward along its track.

HOW TO GET GOOD RESULTS

To secure good posts with either method the following points must be observed: Molds should be coated with only a film of oil. Concrete aggregates should be of two sizes, well graded, the fine up to $\frac{1}{4}$ in., and the coarse from $\frac{1}{4}$ to $\frac{1}{2}$ in., for the smaller sections of post, and from $\frac{1}{4}$ to $\frac{3}{4}$ in. for the larger posts. The mixture must be very accurately proportioned, analyses being desirable to determine the exact proportions; generally about 1 part of cement of 3 parts, by volume, of aggregates gave the best results. The concrete must be

thoroughly mixed and of wet consistency. The ends of molds must be sealed tightly with clay, plaster of Paris or cement, to insure good tops.

The air must be expelled by jogging and running a trowel back and forth through the mixture and along the sides of the mold while placing. The reinforcement must be placed in correct position; this can be accomplished without a spacing device after a workman becomes skilled.

WIRES SHOULD BE RUSTED

The reinforcing metal, particularly round wires, should be thoroughly rusted or nicked to give a proper bond. Bending the ends of these wires back 180 deg. gave good results. As received from the mill the wires were greasy from the drawing process, and it was found necessary to hasten rusting by the use of a weak acid, afterward neutralized. Posts tested to failure showed that unrusted straight wires would pull through, whereas properly rusted ones, or those with ends bent, would break. It has been suggested that running the wire through a barbing machine such as is used in the manufacture of barbed wire nails would deform it sufficiently to give a good bond. This would add not over one-half cent per pound to the cost.

Posts must be properly cured. They can be removed from the molds in 30 hr., and may then be stood in approximately vertical positions and water sprayed over them from suitably arranged piping, or, preferably, they may be spaced in horizontal positions and covered with sand or sawdust, kept wet. Curing should cover at least two weeks, and better four. The rounding of edges of the exposed face can be accomplished in the form, but better by rubbing with a carborundum brick after erection and before the wire is stretched. If fencing is attached by wrapping wires, rough edges assist in holding the wires.

HANDLE WITH CARE!

The T-section posts weigh 90 to 100 lb. each, and require very careful handling. They were transported from the casting yard to the work in spring wagons or trucks, generally about 40 posts to the load. Tests showed that the strength of the T-post was greatly increased by substituting three $\frac{1}{4}$ -in. twisted rods for the three No. 5 gage wires, the weight of the reinforcing metal being practically doubled by the change.

Posts were set not less than 30 in. in the ground, and efforts were made to secure a pleasing profile of the tops. It was found very desirable to place stones in the holes around the bottoms of posts and to tamp the refill thoroughly. In swampy ground and where the fence line was curved, posts were generally concreted in, as otherwise the strain of the fencing would throw them out of line. It was found desirable not to set posts in filled ground, as on right-of-way banks, until the filling had stood through at least one winter.

SPACING AND BRACING

Straining posts were placed at irregular intervals to suit the topography and align-

ment, but never exceeding 600 ft.; the average interval was somewhat less than 300 ft. Early experience proved that such posts should be concreted in. Two permanent angle-iron braces were generally used on straining posts, but in case the angle in the line made this impracticable a straining post was set at the angle point and another 16 ft. away, each provided with a single brace. The proper location of straining posts is of great importance if a tight, good-looking fence is desired. Therefore special study of this detail is necessary. Early in the work concrete brace bases were cast and set in position to support the lower end of the angle-iron brace. Better results were secured later by digging a hole and filling with concrete in which the lower end of the brace was set. Gate and latch posts were generally set in concrete, this method proving more effective in preserving alignment. All property-line posts were set with the face on the property line; in other words the posts are entirely on city property.

FACTORY AND FIELD-WOVEN FENCE

Two general types of fencing were used, factory and field-woven, the use of the former being more general. Both types were No. 7 gage throughout, and has seven horizontal strands, all heavily galvanized. The field-woven fencing was of the Knox type, with pickets spaced either 8 or 24 in. This type was used in more conspicuous locations, or over very irregular ground. The factory-woven fencing, made by the American Steel & Wire Company, was delivered in 20-rod rolls, and weighed about 1.1 lb. per foot. The weight of the Knox fencing with 24-in. spacing of pickets is about the same. For erecting factory-woven fence, stretching, wrapping, cutting and crimping tools were required. For erecting the Knox type a pair of light blocks for controlling the strain in each horizontal wire, and a special tool for fastening the pickets to these wires were required.

Many methods of fastening fencing to posts were considered, and the following was finally adopted and successfully used: At end, corner and straining posts the horizontal line wires were carried around the posts and wrapped on themselves, interfering verticals being cut out and the fencing kept under strain while this wrapping was being done. At line posts short wrapping wires, first of No. 12 and later of No. 9 gage, were used. These wires were delivered in bundles, each wire straight and long enough to make two wraps. They were cut into proper lengths, one cut giving the pieces for wrapping the top and bottom horizontal wires, another the second and fifth, etc., thus avoiding any waste.

ATTACHING FENCING TO POSTS

Two men generally worked together attaching these wires. The operation was performed as follows: A short bend was first made near one end, giving sufficient material for wrapping four times around the horizontal wire; it was then placed in position snugly against the side of the post and wrapped. The loose end was then carried snugly around the post and wrapped four times around the line wire on the other side. Care must be taken to keep the wrap in the horizontal plane of the line wire and to have it tight and snug against the post. Done in this way the fencing cannot be lifted up, and the batter of the post prevents sagging. This method

of wrapping is preferred because it does away with special attachment pieces or holes in the posts, permits the stringing of wire any distance above the ground or below the top of the post, and is economical. Wrapping tools can be bought for a few cents from fencing manufacturers, or can be made by a handy blacksmith.

Fencing was erected during practically every month of the year. Probably better results were secured from the warm weather work, although this undoubtedly caused more of a strain on the posts due to contraction in the colder months.

BRACES

Galvanized angle iron braces $2 \times 2 \times \frac{1}{4}$ in. by 7 ft., or $2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$ in. by 9 ft. were used. These were bent to fit the side of the post at one end and the concrete anchorage at the other, with holes at each end for attachment. The better way is to bend the upper ends of these braces at a sharp radius with the slotted hole to permit adjustment on sloping ground where bolted to the posts. The bottom ends can be simply bent down and concreted into the brace block. However, even this type of brace cannot be conveniently cut to length in the field, and those contemplating erection of fences should consider braces of $1\frac{1}{2}$ in. galvanized pipe. These can easily be made in the field to special lengths and the use of couplings prevents wasting short pieces. One end should be flattened down for 4 or 5 in., bent to the desired shape, and drilled for the bolt connection. The other end is bent slightly and concreted into the anchorage or flattened and secured to a bolt in the anchorage. It is understood that reinforced-concrete braces, instead of angle-irons, have been used in the outskirts of Brooklyn for the wire fencing along the Sea Beach route of the new subway system put in operation this summer.

GATES

Gates generally 10 ft. long, made of angles and flats, were used freely in the line and right-of-way fences. A somewhat wider gate opening seems desirable. The top support is made adjustable and all hinge supports, top supports, latch plates and bolts are heavily galvanized. This is desirable when the difficulty of securing a good paint for exposed metal work is considered. Gates are locked by inserting the tongue of a small brass padlock through a hole drilled in the latch.

Experience to date has indicated no likelihood of trouble with the posts, although adjustments of gates and their supporting posts have been necessary, particularly on field rights-of-way. Early in the work the posts offered tempting targets to hunters, but it is believed the novelty has worn off. Frequently, too, some country Hercules would try the strength of the posts after erection and before wires were strung, by pulling back and forth, generally with disaster to the post. Once the wire is strung this danger is removed. The importance of securing dense, smooth tops is obvious, as disintegration by frost action is thereby reduced or eliminated.

It appears to Mr. Wheeler undesirable to attach fencing to either the hinge or latch post of a gate, for sooner or later the strain throws the gate out of line and adjustments are necessary. It is better to set extra posts, one of which should be spaced for a manway. Manway openings should not be too wide, particularly in regions where live

stock is pastured. It is better to make them so that a man must turn sideways and then contract as much as possible to get through. In other words, the opening should not exceed 14 in. at the top if the posts taper; if not, the opening should not exceed 12 in.

The T-section post, from its peculiar shape, is particularly firm in the ground, but above ground it does not look much like a post. Mr. Wheeler suggests for consideration the use of a post of combination section, made up of a T-section below the ground and a D-section above. In this way a maximum of rigidity will be secured, and at the same time a section above ground which resembles an ordinary post.

The cost of fences erected by contract along the Catskill Aqueduct was approximately as follows:

Line fence with straining post and two braces every 300 ft., and line posts at 16-ft. intervals.	
Factory woven type.....	16 to 20 cents per foot
Knox or field woven type.....	19 to 22 cents per foot
Typical right-of-way, approximately 200 ft. long, with the straining and special posts, braces and gates incidental thereto.	
	.39 to 42 cents per foot

The type of fencing affected the cost of rights-of-way very little.

Road Oiler Developed to Meet California Conditions

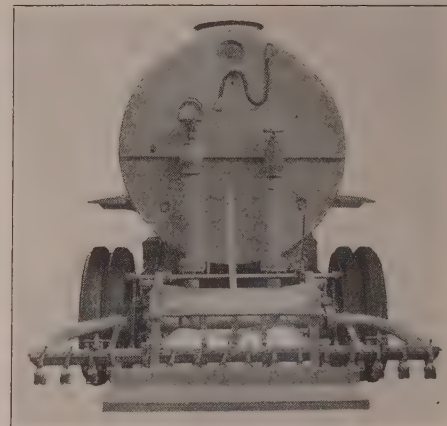
Machine Designed Locally Has Proved More Satisfactory than Those Previously Obtained from Eastern Manufacturers

THE Los Angeles County Highway Commissioners several years ago decided to have local manufacturers build a road oiler which would be better adapted to southern California conditions than the machines which were bought from Eastern manufacturers. A road oiler was therefore designed and built which has, after various changes and improvements based on practical experiments, been developed into a machine which is said to give highly satisfactory results. The accompanying illustrations show one of the trucks built for the Los Angeles Division of the California State Highway Commission embodying all improvements made to date.

The oiler has a capacity of 1000 gal. and is provided with an insulating coat of manganese and asbestos compound 1 in. thick, and protected by an outer sheet of steel. It is designed for handling oil at from 250 to 350 deg. Fahr., and the oil can be kept in the tank for twelve hours without a decrease in temperature of more than 20 or

30 deg. The chief advantage claimed for the machine is its simplicity. The amount of exterior piping is believed to have been reduced to an absolute minimum, and the pump connections are so arranged that oil is easily handled whether loading or delivering in any one of several ways.

The pump is geared to the main driving shaft of the truck and can maintain a circulation of the oil through the boot while the truck is on the way to its work; thus the nozzles are heated and ready for service



CONTROL MECHANISM, REAR END OF OILER

at the moment the truck reaches the road to be oiled. The nozzles, which can be operated either separately or collectively, are designed to give a fan-shaped spray from a single jet. This form of jet is said to be much more satisfactory than the ordinary duplex type. Each nozzle has two nipples, one for a delivery of from $\frac{1}{8}$ to $\frac{3}{8}$ gal. per square yard and the other for from $\frac{1}{2}$ to $1\frac{1}{2}$ gal. per square yard.

Between the pump and the boot a spring relief valve is so connected that if the pressure in the nozzles rises above 25 lb. per square inch an outlet back into the tank is automatically opened. This prevents the delivery of an excessive quantity of oil to the road surface in case the oil pressure is increased for any reason. The pump can draw oil into the tank through the intake shown on the top or can take on or deliver oil through entirely separate intake and outlet pipes at the front end of the tank.

The work near Los Angeles on which oilers of this type are being used is under the immediate supervision of W. W. Patch, division engineer, acting under the direction of A. B. Fletcher, chief engineer of the California Highway Commission.



SIDE VIEW OF OIL DISTRIBUTOR DEVELOPED FOR CALIFORNIA ROAD WORK



53RD STREET BENTS SET IN ADVANCE BECAUSE OF LONG STRINGER SPANS

Mile and a Half of Track on New York Elevated Line Rebuilt in Fourteen Days

Four "Humps" Erected on Express Track Without Interrupting Traffic on Outside Local Tracks—Difficult Erection Problem at Fifty-third Street

ON AUGUST 1 that part of the center or express track on the Ninth Avenue elevated line, New York City, south of Seventieth Street, was cut out of service, and express trains were run on local tracks south of this point. In the succeeding fourteen days a mile and a half of this track was rebuilt, four "humps" similar to that described on page 138 of the Engineering Record of July 31 being constructed. On Sunday, Aug. 15, a train was run over the rebuilt track, and express service was resumed on the usual schedule the next day. At no time was local service interrupted more than a few minutes.

A great deal of preparation was required for this rapid erection. New cross girders were inserted at many points, and a number of new columns were needed also. The old stringers under the express tracks were blocked up on falsework, so that the rivets connecting those to be removed with the cross girders could be replaced with bolts

to allow their rapid dismantling. The new steel was largely delivered in advance and distributed along the street as near as possible where it was to be used. This steel was carefully checked to make sure that every piece would be on hand when it was wanted. The work of strengthening the old cross girders to carry the extra weight was also done in advance.

SEPARATE ORGANIZATION FOR EACH SECTION

A separate organization built each of the four humps, at Fourteenth, Thirty-fourth, Fifty-third and Sixty-sixth Streets. When the preliminary work was done, the track was torn up at each section to be rebuilt, and a traveler similar to that which built the Second Avenue humps, described on page 86 of the Engineering Record of Jan. 16, was set up on the old stringers. Every other panel of these stringers was removed, and, except at Fifty-third Street, the new bents and stringers were placed by the traveler as it moved ahead, as described in the article referred to.

FIFTY-THIRD STREET SECTION INVOLVED DIFFICULT WORK

The Fifty-third Street hump was the key to the whole scheme. It was not built for a station, as were the others, but to pass the express track over the southbound Sixth Avenue track which turns out of Ninth Avenue at Fifty-third Street. Two new cross girders and four new columns were required at this point, and both the Ninth Avenue and the Fifty-third Street elevated structures had to be supported on falsework to set them. The design of this falsework was complicated by scant headroom and the necessity of locating the towers so as not to interfere with double-track trolley operation under the elevated on both streets.

To carry the raised track at this crossing a pair of 28-ton through girders 100 ft. long were required, and the track had to be raised 3½ feet higher than at the

other sections rebuilt. This, and the down grade of the existing structure south of Fifty-third Street, made this hump longer than the others. Then, too, the 60 ft. panels in this section were considerably longer than those at the other points, and the narrow traveler developed to work between the local tracks could not carry a long enough boom to reach out and set the bents ahead of itself. To rebuild this hump in the same time as the more simple sections therefore required more plant and careful planning.

LARGE STIFFLEG DERRICKS REQUIRED

While the preliminary work was being done a heavy steel stiffleg derrick with a 70-ft. boom was set up on towers around the northwest corner of Fifty-third Street and Ninth Avenue as close as possible to the west side of the elevated structure. As soon as the center track was torn up, this derrick erected a traveler equipped with an



"HUMP" ERECTION AT 34TH STREET

electric hoist just south of Fifty-third Street on the old center-track stringers. This traveler faced north. It backed south, setting the steel bents and removing every other panel of the old stringers as it went. The upper corners of these stringers were all burned off as soon as the track was torn up, so that they could be lifted out in a few minutes after being unbolted.

TWO TRAVELERS REQUIRED AT FIFTY-THIRD STREET TO FINISH ON TIME

As soon as this traveler was erected, the big derrick set up a light traveler, or "jinny-wink," operated by a steam hoist from the street below. This traveler faced south and was set on the stringers north of Fifty-third Street. It backed north, erecting the steel bents and removing every other pair of old stringers. The hoist was moved with it on the street below. When the north end of the hump was reached, this traveler erected the wedge-



TRAFFIC STOPPED ONLY A FEW MINUTES TO SET 28-TON GIRDER

shaped stringers which start the rising grade, up to that panel in which the south end of the new stringers rested directly on top of a cross girder. This pair of stringers was set in place, but not riveted.

Meanwhile, the electric traveler had backed down to the south end of the hump and started north again up the new grade, setting the new stringers and moving forward over them. Before it had reached Fifty-third Street the stiffleg derrick had set the bents and 28-ton girders for the crossing over the Fifty-third Street turnout. One of the illustrations shows the second of these girders being set. These girders form a pony span, with the rail midway between their top and bottom flanges, and the traveler would not pass between them at track level. The big derrick therefore picked this traveler up bodily, slid it along the top of the girder span, and deposited it on the next pair of stringers at the north end as soon as these had been raised. The big derrick was then taken down. Meanwhile the traveler moved down the north slope of the hump, setting the remaining stringers as it went, until it came face to face with the jinny-wink at the north end of the reconstruction. Here the jinny-wink dismantled it and lowered it to the street. The last pair of stringers set by the jinny-wink, which had not been riveted, were slid apart to permit lowering the electric hoist. The small traveler replaced these, and was then itself taken down and lowered to the street.

PLATFORMS FINISHED AFTER EXPRESS SERVICE IS RESUMED

At the other three "humps," where station platforms had to be erected, the main traveler set only the first panel of each platform. On this was set a jinny-wink in each case, and the platform erection is now proceeding at the three stations without interference with traffic on the express tracks. The track in each case was laid behind the travelers, the materials being delivered by work train. In this way, by the time the steel was set the new track was practically ready for operation.

All steel was delivered and removed by teams on the street, and, except for the 28-ton girders at Fifty-third Street, hoisted up between the two outside local tracks. The longest delay to traffic on these tracks was 18 min., while one of the big girders at Fifty-third Street was being set.

Except the replacing of the third-rail and electric connections, which was done by the forces of the Interborough Rapid Transit Company, all the construction described was carried out for the Interborough under the general contract for the Manhattan elevated improvements, held by the T. A. Gillespie Company, executive, the Terry & Tench Company, Inc., and the Snare & Triest Company. The whole work is under the direction and supervision of the T. A. Gillespie Company, with Edward J. Govern as vice-president in direct charge. The forces of the Snare & Triest Company, under W. P. Rothrock as engineer, rebuilt the Sixty-sixth Street hump, while the other work was handled by forces of the Terry & Tench Company, Inc., under W. R. Coppage as general superintendent. George H. Pegram, chief engineer, F. W. Gardiner, principal assistant engineer, and S. Johannesson, general assistant engineer, of the Interborough Rapid Transit Company, had charge of the design and supervision of the work.

Chicago Takes a Traffic Census of the Loop

Bureau of Streets Seeks Relationship Between Density of Traffic and Its Waste-Collection and Pavement Problems

IN ORDER to ascertain the effect of traffic density on street cleaning, and for its value in determining the kind of pavement which should be laid on certain streets, Chicago's Bureau of Streets took between July 13 and Aug. 17 a traffic count of all vehicles passing through specified blocks in each direction.

The field force used in making the count consisted of twelve men divided into six groups of two each, five squads being for actual service and one for relief. The men were all section foremen from the various city wards. Previous to beginning the work they were cautioned as to the necessity of accuracy. A team of men was assigned to a block, one on each side of the street, to count the traffic in one direction only. Observations were made in forty-three different blocks, between the hours of 8 a. m. and 12 noon and 1 p. m. and 6 p. m., rain or shine. On Saturdays the men worked from 8 a. m. to 2 p. m. This afforded a means of counting the noon-hour traffic.

The following traffic statistics at different points in the downtown business and commercial districts were compiled for comparative purposes. They show the variations in conditions encountered as well as the congestion at specific points.

DENSEST TRAFFIC IN CHICAGO

The census taken at the Rush Street bridge revealed the fact that at this point traffic is heavier than at any other point in the city. For the 8 hr. in which the census was taken an average of 1700 vehicles per hour crossed the bridge during the day, or a vehicle every 2.12 seconds. Between 5 and 6 p. m. the traffic reached the peak, 2384 vehicles crossing the bridge during the hour—an average of a vehicle every 1.56 sec. The trend of traffic at this time is northbound, 1872 conveyances passing over the bridge in that direction. The difficulty which a pedestrian encounters in trying to cross the bridge during the rush hour can be imagined with a vehicle of some kind passing every 1.56 sec. Traffic across the bridge was distributed as follows: Horse-drawn vehicles, 19 per cent; auto trucks of all kinds, 6.3 per cent; automobiles, 74.7 per cent.

BUSIEST STREET INTERSECTION

The intersection of State and Madison Streets was found to be the busiest crossing in the loop, an average of 1548 vehicles passing per hour, or one every 2.4 sec. Street cars were found to run 11.8 sec. apart. Traffic was distributed as follows: Horse-drawn vehicles, 43.2 per cent, auto trucks of all kinds, 7.4 per cent; automobiles, 29.7 per cent and street cars, 19.7 per cent. Of this traffic 75.7 per cent was on State Street and 24.3 per cent on Madison Street. Traffic northbound in the block between Madison and Washington Streets was 35 per cent heavier than that southbound, despite the fact that there were 245 more street cars southbound than in any other direction.

Figures taken at eleven different points on streets west of State Street show traffic to average 254 vehicles per hour. At

eleven different points on streets east of State Street, the average per hour was 192. Between Lake and Adams Streets on State Street an average of 442 vehicles per hour was counted.

In order to ascertain the length of time spent by vehicles standing backed up to the curb in loading and unloading on South Water Street and streets in the immediate vicinity, eighty vehicles of outside dealers were timed. These were found to stand at the curb an average of 1 hr. and 27 min., while ten other vehicles remained for an average of 4 hr. and 9 min. The vehicles used for hauling fruit and produce to the commission houses averaged from 15 to 30 min. in unloading and departing, while a number owned by parties who do a cartage business, after unloading, remained backed up to the curb for an indefinite time.

STREET CARS 14.4 PER CENT OF ALL TRAFFIC

That the new-style heavy double-truck street car is as important a factor in the traffic census as it is in street cleaning may be seen when it is considered that of all the conveyances counted, there were 26,995 street cars or 14.4 per cent of all traffic, and on the streets on which there are tracks the street cars amounted to 21.1 per cent of the traffic. Of the streets on which there are regularly routed street cars, Dearborn Street south of Monroe Street had the lightest amount of street-car traffic. The greatest amount was found on the three-track State Street line, between Lake and Madison Streets, the street cars being nearly 26 per cent of the total traffic. At the intersection of State and Madison Streets there is an average of one car every 11.8 sec. in all four directions.

Of the 100,727 vehicles used for commercial purposes in the cartage of freight and other commodities, 82.2 per cent were horse-drawn and 17.8 per cent were auto trucks of all descriptions. Of the 59,950 carriages, buggies and automobiles used for carrying passengers, 0.9 were carriages, 2.2 per cent were buggies, 19.2 per cent were single-seated automobiles and 77.7 were automobiles with seats for four or more. This gives the percentage of horse-drawn vehicles to automobiles, 3.1 per cent to 96.9 per cent.

The total count showed that all traffic counted in the loop was distributed as follows: Horse-drawn vehicles, 45.1 per cent; motor-driven vehicles other than street cars, 40.5 per cent, and street cars, 14.4 per cent. The average number of vehicles per hour was 258 and the total hours counted 728.

The estimated tonnage used for each class of vehicle is the same as that adopted by the Bureau of Highways, Brooklyn, N. Y., which is as follows:

	Tons
Rubber-tired vehicles	
Large auto trucks, loaded.....	8
Large auto trucks, empty.....	4
Small auto trucks, loaded.....	3
Small auto trucks, empty.....	1½
Automobiles.....	1½
Wagons and carriages.....	1½
Iron-tired vehicles	
Three-horse trucks, loaded.....	7½
Three-horse trucks, empty.....	3½
Two-horse wagons, loaded.....	4
Two-horse wagons, empty.....	2
One-horse wagons, loaded.....	2
One-horse wagons, empty.....	1

The entire count was under the direct supervision of Charles Smith, ward superintendent; W. J. Galligan, second assistant superintendent of streets, reporting to Walter Leininger, superintendent of streets.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

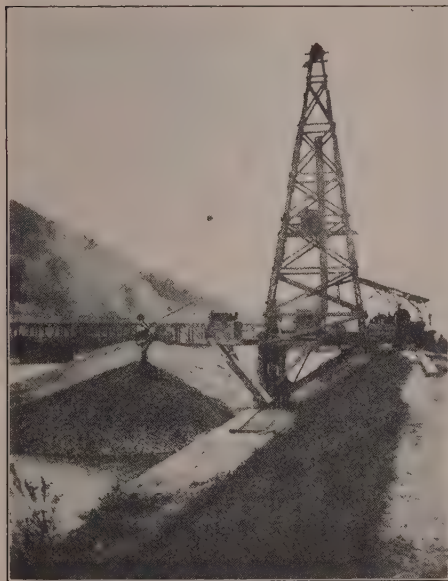
[Contributions to this section are solicited, and if found available will be paid for. They must be SHORT, and should be accompanied, if possible, by photographs or sketches.—EDITOR.]

Dragline Fills In Ahead of Itself for Its Own Track

By LEON C. HEILBRONNER

Eastover Construction Company, Inc., Utica, N. Y.

THE ACCOMPANYING photographs show a drag-line tower mounted on a levee bank, which fills in ahead of itself for its own lower track. The Eastover Construction Company, Inc., is the contractor for excavating a channel through an island in the Chemung River at Corning. The completed channel is to be 85 ft. wide on the



FRONT OF TOWER ROLLS ON CAR TRUCKS

bottom with side slopes of $1\frac{1}{2}$ to 1. The material excavated, which is all gravel, is to be wasted along the base of an existing dike on the north side of the river about 550 ft. from the channel. An 80-ft. dragline tower was erected, operating a $1\frac{1}{2}$ -yd. bucket, a 100-hp. boiler and a 12 x 14 hoisting engine being used. The tower was at first operated at the base of the dike on a fill 7 ft. above the river bed. The base of the tower, however, was so long as to prevent the material being brought near enough to the base of the dike to fulfill the specifications. Therefore it was decided to place the rear end on the top of the dike. This brings the front end at the toe of the dike, but 21 ft. above the bed of the river. Three standard-gage freight car trucks were connected and 12 x 12-in. timber columns placed on them and under the base of the tower at the front end. The tower is therefore supported only for about 8 ft. at the rear and 5 ft. at the front.

So that the track for the front end can be kept above ordinary high water at the least expense, a small hopper is placed on the front of the tower just above the base,



SPOUT FILLS TRACK AHEAD OF TOWER

and a 16 ft. dredge pipe with rubber connections hooked on to it. As soon as the tower is moved the bucket dumps into the hopper and the fill for the next section of track is made and graded.

With this outfit 500 cu. yd. per 8-hr. day is excavated, including time taken in moving.

Tunnel Driven Under Inclined Railway with Thin Earth Cover

By R. A. RILEY

Riley-Knapp Construction Company, Pottsville, Pa.

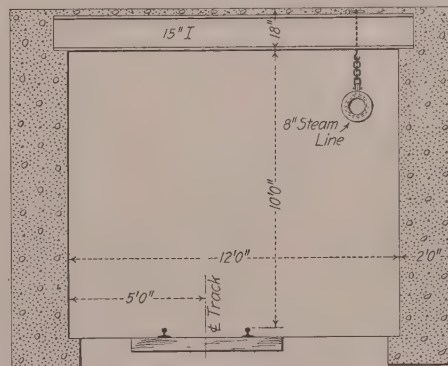
A TUNNEL, driven with thin earth cover under an inclined railway which carried heavy traffic, has recently been completed at Frackville, Pa. The inclined railway is known as the Mahanoy Plane. The tunnel was designed for the purpose of hauling coal to the breaker in the operation of the Maderia Hill Coal Company's mine. The plane under which the tunnel is driven is a double-track cable hoist about 4000 ft. long, having an average grade of about 10 per cent. The Philadelphia & Reading Railway uses it to hoist its coal from the Mahanoy Valley to the top of Broad Mountain from where it is taken down the Schuylkill Valley to the Philadelphia market.

The Maderia Hill Company planned to mine coal on both sides of the plane, and was building a large breaker on the east

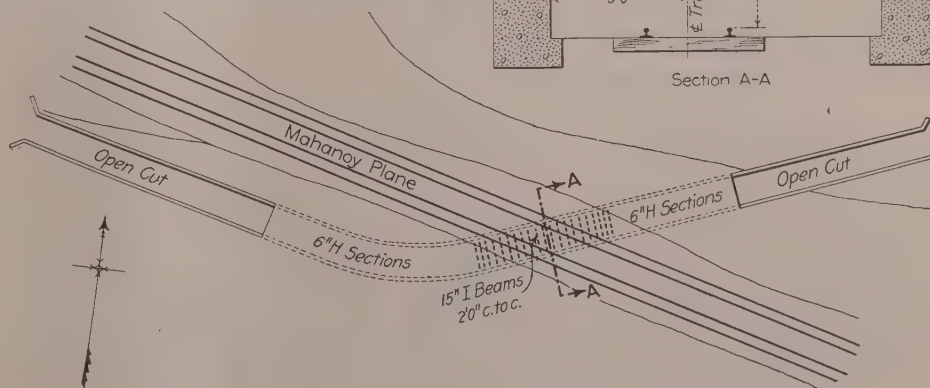
side. In order to bring coal from the west side to the breaker the company had either to construct an overhead crossing or to drive a tunnel. The plane was operated by an engineer from a tower at its head. The construction of an overhead bridge would obstruct his view, and consequently the idea of the bridge was abandoned.

The tunnel section is rectangular, 16 ft. wide and 13 ft. high in outside dimensions, the roof being made of I-beams encased in concrete. The center line of tunnel crossed the plane on an acute angle, consequently the distance from the roof of the tunnel to the rail of the plane varied from 20 ft. on the east side to 11 ft. on the west side. The material between the roof of the tunnel and the plane consisted of clay and gravel. This material was very difficult to undermine, both because of its nature and because of the continuous pounding of the traffic on the plane, on which four 50-ton coal cars crossed the tunnel every 2 minutes. The cross-section of the tunnel took in about one-third clay and gravel, one-third the Little Buck Mountain vein of coal, and one-third the underlying rock, all pitched on an angle of about 60 deg. The rock occupied one corner of the section all the way through.

All materials were furnished by the mining company. For upright timbers 14-in. yellow pine was used. For collars 6-in. yellow pine was tried, but found too weak, and 16-in. oak was substituted. Directly under the plane where the impact was worst center props were placed under the collars until the I-beams were set. The tunnel was driven from both ends, taking out the full section without any advance heading except what was necessary in driving the fore poles ahead. The timbers were spaced every 3 ft. The mode of procedure, once the timbering was fairly under way, was to



Section A-A



TUNNEL DRIVEN WHILE RAILWAY HANDLED TRAIN EVERY TWO MINUTES

drive fore poles ahead and take out a bench about 3 ft. deep and 6 ft. high, placing the collar and bracing it. Next the excavation was made for the low-side leg, which was unusually in the vein of coal. The rock on the high side was then drilled for the collar or for a short leg if the rock was not high enough for the collar to rest on directly. The rest of the material was then removed by blasting and shoveling. One-yard rolling dump cars pulled by mules were used for removing the muck. The



THIN COVER MADE WORK DIFFICULT

drilling was done with two jack-hammers supplied with air from a company compressor installed near the tunnel portal.

The concrete work followed up the timbering as fast as possible, being started as soon as the headings reached the plane. Concrete was placed in about 20-ft. sections, and kept about 20 ft. behind the heading. This was done in order to make the span supported by timbers as small as possible to reduce the risk of a cave-in. Concrete materials were delivered by the plane, but because of the steep slope and the short space between the ends of the tunnel and the sides of the plane it was not thought advisable to set up a mixer and spout concrete through the roof. Consequently the concrete materials were unloaded from the plane (during dinner hour) and then shoveled through a chute in the roof of the tunnel to a mixing platform

inside. Here the concrete was mixed by hand and shoveled directly into the wall forms and the roof. Thus, the concreting did not interfere with driving the tunnel, except for some slight damage done to the forms by blasting.

The work was carried on at the rate of 3 ft. per day, and a night shift was used about half the time. The cost of tunneling, the timber, track and power being supplied by the mining company, was \$3.24 per cubic yard of \$74.85 per linear yard. The concrete, for which materials were supplied by the mining company, cost \$2.11 per cubic yard. It cost \$0.0013 per pound to place the steel I-beams with their sheet-iron arches.

Use of Wrecking Crane Saved Money on Small Job

By R. C. HARDMAN
Colorado Springs, Colo.

SEEING the possibilities of a construction situation and making the best use of the facilities at hand, even when they do not happen to be the facilities reasonably provided to do the job, is an excellent way to save money. This is especially true on small construction work, where the cost of performing certain classes of work is made exceedingly high by the lack of the proper equipment, the purchase or rental of which would be out of all proportion to the size of the work.

The writer recently had charge of the construction of a reinforced-concrete viaduct in which twelve steel plate-girders were used to carry the floor over railroad tracks. Six of these girders were 62 ft. in length and were placed 23 ft. above the top of rail. The remaining six were 67 ft. in length and 26 ft. above top of rail. The weight per girder varied from 4½ to 5½ tons. Equipment for placing these girders could not be provided on a concrete job, where they formed the only item of heavy steel to be set, and some concern was had as to the best and most economical method of erection. The problem was further complicated by the fact that they were to be placed over the main lines of two important railroads. The cost of assembling the simplest kind of hoisting equipment would have been prohibitive. Finally arrangements were made for the use of a large railroad wrecking crane.

The crane, which had a capacity of 220 tons, was operated by its regular crew, with a switch engine in attendance. Although the

crane was self-propelling, the extra engine was provided to keep the outfit safely out of the way of passing trains.

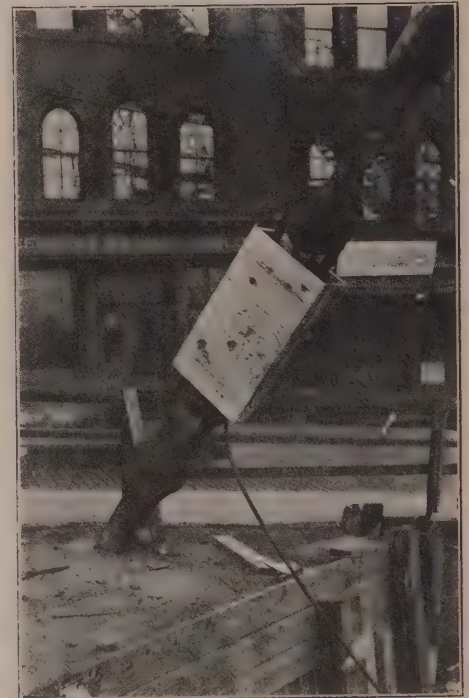
The girders had previously been unloaded from flats by hand, consequently assorting them had not been feasible. Preparatory to erecting the crane had to pick out the girders needed in the proper order. For one span these were handled from a track about 100 ft. distant from the location of the girders, for the second span they were dragged by cable about 300 ft., picked up, carried about 300 ft. down the track and placed into position.

The time consumed in placing the girders was a day and a half, although the actual working time was very much less. The last six girders, by far the most difficult, were placed in 3 hr., or 30 min. each; this time included snaking the girders over to the track, picking up, moving the crane under the span and hoisting the girders and placing them upon their seats.

The cost of the work was about \$4.70 per ton, which was a great deal less than the work would have cost if done by other available methods.

Boxing Cableway Anchorage Prevents Tampering with Clips

THE ANCHORAGE of the guys for the twin cableways used in building the Detroit-Superior bridge in Cleveland are boxed, as shown in the photograph, to prevent mischievous persons from tampering



BOX PREVENTS MEDDLING WITH CLIPS

with the cable clamps and endangering the lives of the men on the work. This was found necessary because the anchorages are "outside the fence" where any passerby on the street can get at them.

The viaduct is being built by the Hunkin-Conkey Construction Company, for whom Harry Hilton is engineer and Harold E. Ketchum superintendent.



USING RAILROAD EQUIPMENT SAVED TIME IN ERECTING CROSSING VIADUCT

A FIGURE-EIGHT SCENIC BOULEVARD is being laid out around the summits of Twin Peaks, the highest points in the city of San Francisco.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Construction on Philadelphia's New Subway Begun

Mayor Blankenburg, in Presence of Great Throng, Turns First Spadeful of Earth on Afternoon of September 11

On the afternoon of Sept. 11 the public ceremony which marked the beginning of construction on Philadelphia's new subways was opened by the turning of the first spadeful of earth with a silver shovel, wielded by Mayor Blankenburg. This ceremony, which was witnessed by the mayor's cabinet, members of the City Council and of the department of city transit, and thousands of citizens, took place at the northwest corner of the City Hall Plaza. It was followed with speeches by A. Merritt Taylor, director of the department of city transit, and by Mayor Blankenburg.

who led the way about the works. Although the visitors felt the intense heat of the afternoon considerably, it did not lessen their interest in the imposing structure or deter them from going up and down any of the steep inclines that had to be surmounted to get a thorough understanding of its several features. The arrangements went through without a hitch, ample time being provided to inspect the works without having to hurry back to catch the train for the return trip.

Western Society's First Fall Session a Military Meeting

The first meeting of the Western Society of Engineers on Sept. 11, following the summer vacation period, was devoted to a description of the 1915 engineers' camp at Belvoir Tract, Va., by Lieut. H. S. Baker, Corps of Engineers,

Road Congress Advocates Continuity of Policy

At Pan-American Joint Meeting Speakers Emphasize Need for Stable Organization and Long Tenure of Office for Engineers

(By Telegraph from San Francisco)

The Pan-American Road Congress, which opened its five-day session at Oakland, Cal., Sept. 13, combines for the first time the annual meetings of the American Highway Association and the American Road Builders' Association. The joint committee which was appointed to plan the sessions arranged to include in the congress the Tri-State Good Roads Association and the Pacific Highway Association, and as a result of this four-fold combination the discussion of papers covered unusual scope and breadth of experience.

The opening attendance was small compared to what might have been expected for a meeting of this character nearer the Eastern centers, but the manifest interest of those who had come far, coupled with the enthusiasm of Western delegates, more than compensated for the small number. The opening session was presided over by John H. MacDonald, former State highway commissioner of Connecticut. A notable feature of the early sessions when delegates were getting acquainted was that even veteran members of the associations met an unusual number of strangers. This was doubtless due in part to the joint meeting, but also because it was possible for many Western States to send more delegates than on former occasions.

Long Tenure of Office

Presidential addresses by Fairfax Harrison, for the Highway Association, and George W. Tillson, for the Road Builders' Association, emphasized the need for giving highway officials long tenure of office. There must be continuity of policy to insure success in carrying out the construction of any highway system, and stress was laid upon the great hindrance to the good roads movement arising from political interference in the management of highway commission matters. The elimination of wastefulness in highway construction, regarded as one of the primary purposes of the associations, could only be accomplished, it was shown, by planning and carrying out the work on a strictly engineering basis. Responsibility for directing the work should rest on a single individual or a commission of the smallest number feasible, appointed for long-term service. In this regard a sharp comparison was drawn between the history of highway work in the States of New York and Massachusetts.

In discussing the paper on "History and Future of Highway Improvement," by Logan Waller Page, it developed that laws are being urged in some States which would require counties to provide for the maintenance of roads at the same time that bonds for this construction are issued. Some States do this already, while others expect the sentiment against poorly kept roads to constitute a pressure enforcing proper repairs. In others the State takes over the maintenance of roads after they are properly built. Emphasis was placed on the necessity of recognizing the need for various types of construction on a single highway system, each suited to traffic requirements in a certain district. Citation was made of one highway system on which the same construction was used for the entire mileage, although 20 per cent of the road carried 75 per cent of the traffic.

It was pointed out that the steam age has centered people in cities and that now we are



A. M. TAYLOR (WITH PICK) AND MAYOR BLANKENBURG (WITH SHOVEL) START CONSTRUCTION OF PHILADELPHIA'S NEW HIGH-SPEED SUBWAY LINES

The first contracts for sections of the new transit lines were awarded on bids opened Aug. 16, for the City Hall section of the Broad Street subway and for constructing foundations for four miles of the Frankford elevated line. Some of the careful and thorough methods employed in locating and designing Philadelphia's new high-speed lines, as well as the progress of the city's fight for adequate transit facilities, have been noted this year in the Engineering Record of May 1, page 567, and of Aug. 21, page 242.

Trip to Kensico Dam Terminates Waterworks Convention

The convention of the New England Waterworks Association held in New York City, Sept. 7-9, an account of which was published in this journal last week, ended with an excursion to Kensico dam at Valhalla, on the afternoon of Sept. 9. The trip was made by special train, in which there was more than ample accommodation for all the excursionists. At Valhalla the party was met by several members of the engineering force at the dam,

Illinois National Guard. Capt. L. S. Marsh, Lieutenant Guilford, Sergeant Saner and Private Tomlinson amplified Lieutenant Baker's talk from the different angles of their respective ranks. Military matters are uppermost in the minds of Chicago engineers these days, for 10 per cent of the men who have enlisted for the citizens' camp at Fort Sheridan are engineers. In consequence there was an attendance of 130, despite the hot night.

Ernest McCullough is scheduled to speak on Sept. 20 on "The Engineering Society—Its Past, Present and Future Activities." Some of the subjects for coming meetings are: "Public Health Service," by Earle B. Phelps; "Currents of Lake Michigan and Their Influence on the Climate of Neighboring States," by Col. C. McD. Townsend, president, Mississippi River Commission; "Chicago Terminals," by Dean W. F. M. Goss; "Construction Features of the Winnipeg Aqueduct," by James H. Fuertes; "The Relations of the Railroads and the Public," by L. E. Johnson, president, Norfolk & Western Railway; "The Design of Pontoon Bridges," by H. J. Hansen, and "Ventilation," by Dr. E. V. Hill.

entering the gasoline age, which is distributing the population into the country again. The fact that in this country farmers own a large and rapidly increasing percentage of the automobiles was cited as evidence that there is to come yet stronger and more intelligent support for good roads propaganda.

Who Shall Supervise Roads?

A paper on rural supervision of road construction, by C. L. Mackenzie, president of the Washington Good Roads Association, provoked much discussion on the question of whether road building should be under the supervision of county, State or Federal authority. Mr. Mackenzie believed that since 90 per cent of all road traffic is local, administration of road matters is most effective under local management. Experience in Washington confirmed this, he thought. C. A. Kenyon, president of the Indiana Good Roads Association, cited experience in that State where roads are built under local management. Indiana is now carrying \$35,000,000 worth of 20-year serial bonds, the type of construction being uniformly gravel roads, costing \$1,500 per mile. He deplored and strongly disapproved of the Indiana system and suggested that all proposed roads might well be classified as to distribution of nature of traffic and supervision into county, State and Federal roads, each classification to be built by the respective authorities. Without Federal aid, it was pointed out, roads could not be built across the swamp and marsh lands of the South or the desert land of the Southwest. The question was then asked, "If a State highway commission is good for administering State highways why not a Federal highway commission for directing National road building affairs?"

Well-Known Engineers Named on Naval Advisory Board

Among those selected as members of the Naval Advisory Board, as announced by Secretary Daniels, Sept. 12, civil engineers and those whose activities have brought them in close contact with the civil engineering profession figure prominently. Among those named are: Alfred Craven, chief engineer of the New York Public Service Commission, First District; Andrew M. Hunt, consulting engineer, of San Francisco; William L. Saunders, chairman of the board of directors of the Ingersoll-Rand Company and president of the American Institute of Mining Engineers; Frank J. Sprague, consulting engineer, of New York City, and vice-president of the Sprague Safety Control & Signal Corporation, and Dr. R. S. Woodward, civil engineer, astronomer and geographer, who was for several years connected with the U. S. Coast and Geodetic Survey.

Alfred Craven

Alfred Craven was educated at the U. S. Naval Academy, from which he was graduated in 1867. After serving four years in the naval service, he resigned to engage in engineering work for the California State Geological Survey. In 1873 he entered private practice in California and other western States and continued in it until 1884, when he came to New York and was appointed assistant engineer on the forces of the New York Aqueduct Commission. His connection with the subway system dates from 1900, when he was appointed division engineer of the New York Rapid Transit Railroad Commission. In 1905 he was promoted to the grade of deputy chief engineer, which office he held until the creation of the Public Service Commission in 1907, when he was appointed deputy engineer of subway construction. In 1910 he served as acting chief engineer. He attained the office of chief engineer in 1910.

Andrew M. Hunt

Andrew M. Hunt was graduated from the U. S. Naval Academy in 1879 and served as

engineer officer in the navy until 1894, when he resigned his commission to enter consulting practice in San Francisco in partnership with W. F. C. Hasson. This firm, previous to 1897, acted in a consulting capacity on the work of changing the cable roads of the Los Angeles Railway Company to electric and designed and installed the hydroelectric plant of the Victoria Electric Power Company, at Victoria, B. C., and a 800-kw. hydroelectric plant for the Nevada County Power Company. From 1897 to 1898 he was in Alaska where he constructed four steamers for work on the Yukon River. In 1899 he resumed consulting practice in San Francisco in association with E. H. Benjamin and Wynn Meredith. This firm designed and installed various hydroelectric plants, one of which, that of the Vancouver Power Company, Ltd., at Vancouver, B. C., cost approximately \$1,000,000 and involved the construction of a water tunnel 13,000 ft. in length.

William L. Saunders

William L. Saunders was graduated from the University of Pennsylvania in 1876 and,

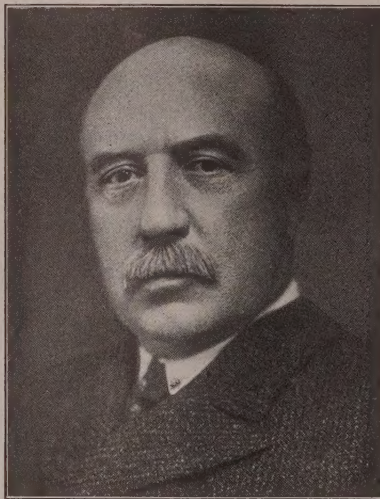
years he was assistant astronomer of the U. S. Transit of Venus Commission and, from 1884 to 1890, was chief geographer of the U. S. Geological Survey. From this work he went to the Coast and Geodetic Survey as assistant and, in 1893, resigned to become professor of mechanics and mathematical physics at Columbia University. In 1895 he was appointed dean of the school of pure science at that university. He held this office until 1904 when he was elected president of the Carnegie Institute at Washington, D. C.

Smoke Prevention Equipment Near Standardization

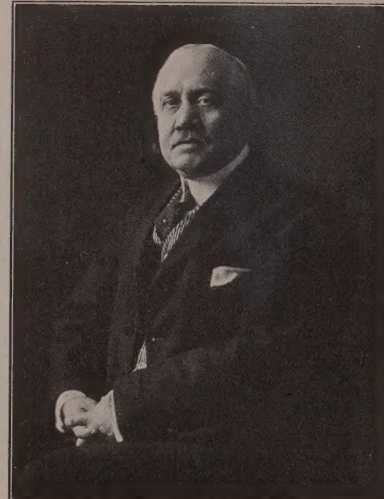
Growth in Uniformity of Practice Indicated at Association's Convention in Cincinnati Last Week

The general thought brought out by the papers presented at the annual convention of the International Association for the Prevention of Smoke, held at Cincinnati last week, was to the effect that equipment for suppres-

New York Public Service Chief Engineer and Compressed Air Authority Chosen as Members of Naval Advisory Board



ALFRED CRAVEN



WILLIAM L. SAUNDERS

from 1878 to 1881, was in charge of hydrographic work and subaqueous rock excavation at Black Tom Island, New York Harbor. Since then he has been identified continuously with the interests that are now included in the Ingersoll-Rand Company. He is the inventor of many rock drilling devices and is the author of "Compressed Air Production," and "Compressed Air Information," and co-author of "Rock Drilling," by Dana and Saunders, and "The Subways and Tunnels of New York."

Frank L. Sprague

Frank L. Sprague received his professional education at the U. S. Naval Academy, from which he was graduated in 1878, and was in the naval service until 1883, when he resigned to become assistant to Thomas A. Edison. In 1886 he began electric railway experiments on the New York City Elevated Railway and, in 1887 and 1888, constructed the Richmond Union Railway. He developed the Multiple Unit System of electric railways in 1897 and has built or equipped more than 150 electric railway systems.

Dr. R. S. Woodward

Dr. R. S. Woodward was graduated from the University of Michigan in 1872 and served as assistant engineer of the U. S. Lake Survey from that year until 1882. For the next two

sion of smoke in stationary and locomotive practice was rapidly becoming standardized, but that considerable research is still necessary in the special application of furnaces to commercial processes, such as metallurgical work in connection with powdered coal, producer gas, etc. It was decided at this convention to change the name of the association to the Smoke Prevention Association and to admit to active membership anyone interested in smoke abatement.

William A. Hoffman of St. Louis was elected president for the ensuing year; C. W. Heath of Cincinnati, vice-president, and F. A. Chambers of Chicago, secretary-treasurer. St. Louis was selected as the place of next meeting, which was set for September, 1916.

The first afternoon of the three-day meeting was devoted to the general questions involved in smoke abatement work, with special reference to organization and the relation of the department to the public. "Civic Phases of the Smoke Problem," by John O'Connor, Jr., of the Mellon Institute of Industrial Research, covered these points. Other papers at this session were, "Starting the Work of a Smoke Department," by Martin A. Rooney of Nashville, Tenn., and "Value of Publicity," by J. W. Henderson of Pittsburgh.

(Continued on page 370, first column.)

Baltimore Filtration Plant Placed in Service This Week

Rapid Sand Plant at Lake Montebello Opened with Formal Ceremonies September 13—
Works Comprise 32 Filter Units, Each Having a Normal Capacity of 4,000,000 Gallons Daily

Baltimore's rapid filtration plant at Lake Montebello was formally dedicated and placed in operation on the morning of Sept. 13. The program for the ceremony, which was presided over by Robert L. Clemmitt, president of the Water Board, included the following addresses: "Baltimore's New Improvements," by Mayor James H. Preston; "Historical Sketch of Baltimore's Waterworks," by Richard Bernard, member of the Water Board; "Relation of Water Supply to Public Health," by Granville R. Jones, professor of sanitary engineering at Johns-Hopkins University; "Tuning-up the Filtration Plant," by James W. Armstrong,

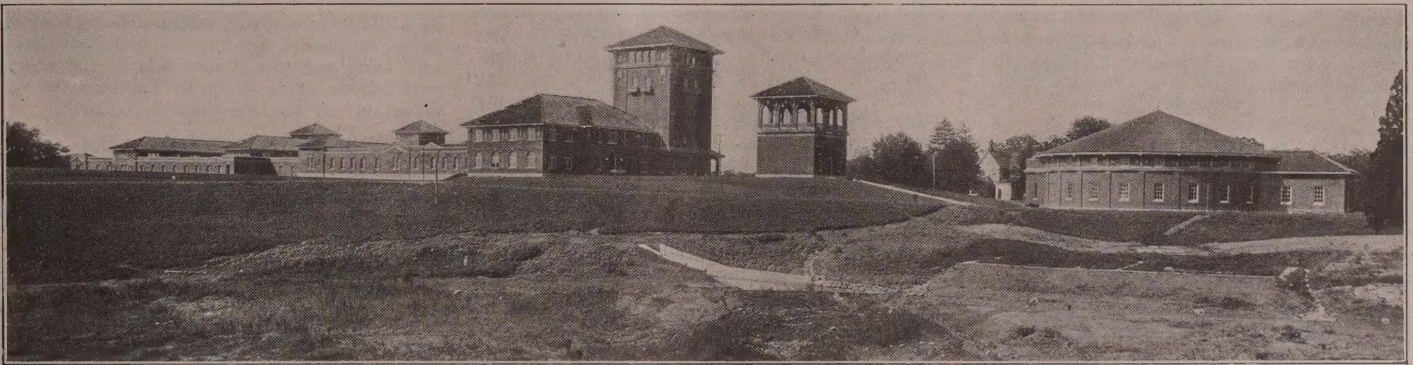
engineer of filtration; and "How the \$5,000,000 Loan Was Spent," by Ezra B. Whitman, consulting engineer.

The Montebello filters comprise thirty-two rapid sand units, each having a normal capacity of 4,000,000 gal. daily. They are designed to operate at a rate of 125,000,000 gal. per acre daily. The chemicals used in the treatment of the water are common lime, hypochlorite, and sulphate of iron. There are two filtered water reservoirs, covered by ground arch concrete vaulting, each holding 7,500,000 gal. They cover a ground area of 250 x 500 ft.

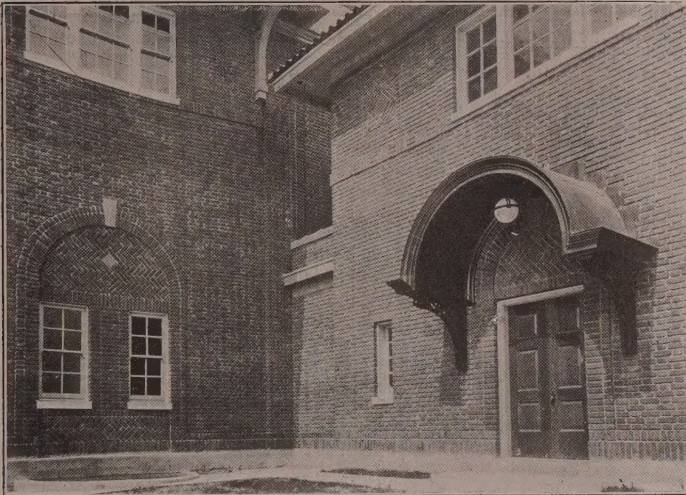
Montebello is a place of more than ordinary

natural beauty, and, as the plant is conspicuous from numerous viewpoints, it has been the aim of the designers to make the buildings harmonize with the natural surroundings.

All buildings are of similar design and construction. The structural portions are built of reinforced concrete, and the exteriors are covered with a local red brick of a pleasing soft color. The trimmings and belt courses are of a buff colored glazed terra cotta. The roofs are pitched 30 deg. and have overhanging eaves without gutters. They are covered with dark green, glazed Spanish tiles, supported on a cinder concrete roof carried by steel trusses.



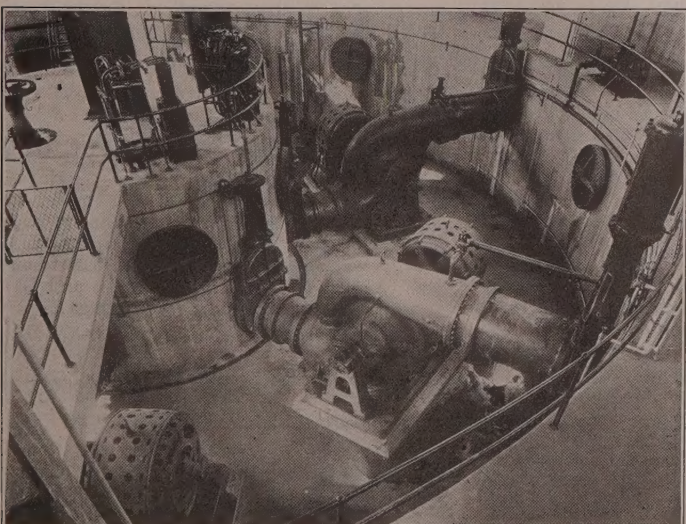
THE BUILDINGS OF THE NEW FILTER PLANT ARE OF RED BRICK AND THE ROOFS ARE COVERED WITH DARK GREEN TILE



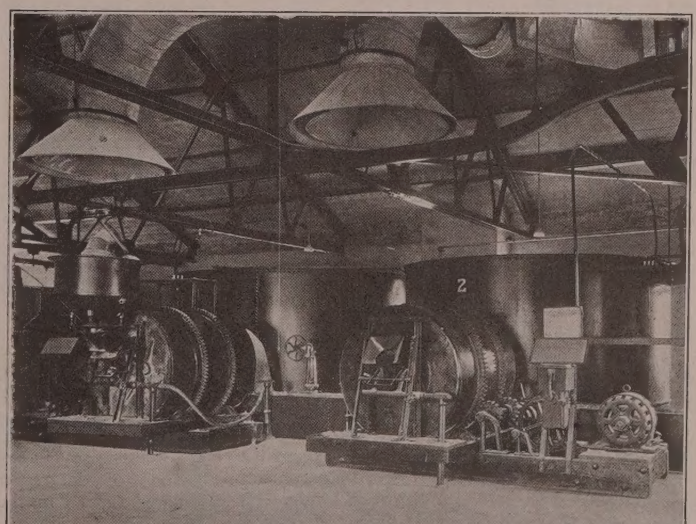
TREATMENT OF TYPICAL ENTRANCE



ONE OF THE TWO OPERATING GALLERIES



CIRCULAR PUMPING STATION 23 FEET BELOW GROUND



WHERE THE CHEMICAL SOLUTIONS ARE PREPARED

One entire forenoon was given over to the discussion of railroad smoke. The papers presented were "Smokeless Operation Without Special Apparatus," by H. H. Maxfield; "Eliminating Smoke from Round-Houses," by M. D. Franey of Elkhart, Ind.; "How Smokeless Operation of Locomotives Was Obtained in Washington, D. C.," and "What the Railroads Have Done to Abate Smoke in Cincinnati," by G. H. Funk of Cincinnati.

"Special Furnace Applications to Manufacturing Processes" was the subject of a paper by Joseph Harrington of Chicago. It was followed by a paper on "Enforcing a Smoke Ordinance," by S. H. Viall of Chicago. An illustrated talk on "The Effect of Furnace Design on Fuel Economy in Smoke Abatement" was also given by O. Monnett of Chicago.

The marine situation was covered by Roy L. Peck of Chicago with a paper entitled "Smoke Abatement on Lake and River Steamboats." Another difficult problem was discussed by A. W. Clement of Des Moines, Iowa, with a paper on "Smokeless Combustion as Applied to the Burning of Clay Products."

Health Association Discusses Sewage Treatment

At Rochester Convention Many Subjects in Sanitary Engineering Field Were Dealt With in Papers and Reports

That the Imhoff tank for sewage treatment has followed the German army into Belgium and France since the occupation of those countries by the Teutonic forces, was the information imparted by Dr. Rudolph Hering to the forty-third annual meeting of the American Public Health Convention, held at Mechanics' Institute, Rochester, N. Y., Sept. 6 to 10. The meeting was a joint affair, in which the New York State Sanitary Officers' Association participated. Governor Whitman was tendered a reception and ball at the New York State Armory at which the visiting members and guests were present to the number of 5000. On the evening of Sept. 6 U. S. Surgeon-General W. C. Gorgas spoke of his work in Havana and Panama, and on Sept. 7 an open meeting listened to an address by Secretary of Commerce William C. Redfield.

Discuss Sewage Treatment

The section on sanitary engineering, of which George W. Fuller is chairman, held a joint session Sept. 7 with the section of public health officials, which consisted of a symposium on sewage treatment, largely with reference to isolated installations and small communities. Among the papers presented were: "Institutional Sewage Treatment Plants," by Charles Mebus of Philadelphia; "Sewage Digestion Tanks for Small Towns and Cities," by G. Everet Hill, New York City; "The Sewage Problem in Small Towns," by Paul Hansen, University of Illinois, Urbana, Ill., and "Sewage Disposal Problems of a Coast Summer Resort," by W. E. Brown, York, Me. General considerations were advanced in the handling of sewage from institutions and small communities, the expressed opinion being that the character and completeness of process should depend upon the money available and the kind of supervision and operation obtainable.

Health officers from Virginia, Indiana, Illinois, Saskatchewan and other parts of the continent described the various conditions which confront them. Prof. William T. Sedgwick, in discussing Robert Spurr Weston's paper on self-purification of streams, referred to the fact that some years ago he had stated that it was quiet water which purified itself rather than running water. Dr. Rudolph Hering stated that engineers wanted from the biologists more information as to the relative persistence of bacteria of different kinds. He also stated that the Germans have constructed many Imhoff tanks for sewage treatment in Belgium and portions of France.

The second session of the section on sanitary engineering, Sept. 8, was devoted to descriptions of various features of the convention city. Edwin A. Fisher, city consulting engineer, referred in general terms to the public works of Rochester, and briefly described the policy of the city with reference to its construction and maintenance. John F. Skinner, principal assistant engineer, described the waterworks and sewerage systems. Frederick T. Elwood, city engineer, dealt with the general construction of street pavements, bridges and street lighting. Herbert W. Pierce, commissioner of public works, took as his subject the maintenance and care of streets, including the collection and disposal of ashes, garbage and refuse. Calvin C. Laney, superintendent of parks, described parks and playgrounds.

Rochester has two sewage treatment plants under construction. One, on the shore of Lake Ontario, is the largest installation of Imhoff tanks yet constructed. It is designed for an ultimate population of 400,000. The smaller one consists of grit chambers, Imhoff tank, sprinkling filters and final settling basins, and was described in the Engineering Record of May 29.

Mr. Fisher, in his remarks, paid a glowing tribute to the late Emil Kuichling, who was a native of Rochester and had been closely identified with its waterworks, sewage disposal and street cleaning methods for many years.

The third session of the section, Sept. 9, took up the following program:

"Mosquito Growth in Catch Basins," by Dr. John W. M. Bunker; "Self-Purification of Sewage Polluted Streams," by Robert Spurr Weston; "The Sanitary Control of the Rochester Water Supply," by Charles Wright Dodge; "Studies on the Effect of Chlorine Disinfection Upon the Self-Purification of Streams," by Arthur Lederer and Frank Bachmann; "Purification of Sewage by Aeration and Growth," by H. W. Clark; "Cause of Rapid Increase of Efficiency and Rate of Deep Compared with Shallow Trickling Filters," by H. W. Clark, and "Some Remarks on Activated Sludge," by William T. Carpenter, Brooklyn.

The city of Rochester has no catch-basins. Many speakers, in the discussion of the first paper, held that they should be abolished and the sewers frequently flushed, the flushing to remove odors and deposits and the grit to be removed at the disposal plant as an economic proposition.

Committee Reports

The fourth session, Sept. 10, consisted of reports of committees as follows: Sanitary control of waterways, by Harrison P. Eddy; refuse collection and disposal, by Samuel A. Greeley; recent progress in refuse collection, particularly as relates to the use of motors, by Samuel A. Greeley; street cleaning, by Samuel Whinery; sewerage works and analytical methods, by W. L. Stevenson.

Mr. Greeley's reports showed a mass of material collected on the use of motor trucks in various places, and indicated that improved methods are being tried in all sections of the country. Mr. Eddy stated that streams might properly be divided into two classes, those furnishing water supply, ice and raw food, and those not so used. He also held that the condition of the stream, after pollution had occurred, should be the criterion rather than the character of the discharge which polluted it.

Although Mr. Eddy's remarks were not presented as a formal report, but rather as a statement of means of approaching the problem, they elicited considerable discussion and generally favorable comment.

The report of W. L. Stevenson, assistant engineer, sewage disposal division, Philadelphia, was a very carefully prepared paper. Mr. Stevenson also presented a tentative method of determining the "drainability of sludge" from Emscher tanks.

*Read by title.

†No report.

‡Read by Secretary.

150 Engineers En Route for World Congress

Progress of the Party Which Left New York Last Week by Special Train for San Francisco
(By Mail to The Engineering Record)

With the presidents of all the National engineering societies (except the civil), aboard, and with a party intent on holiday making, the "Engineers' Special," carrying delegates to the International Engineering Congress at San Francisco, is, at this writing (Saturday afternoon, Sept. 11), bowling over the Kansas prairies. One hundred were in the party when the train left New York. Reinforcements have come along the way until the party now numbers 150, cared for in eight Pullmans, a compartment-observation car, two dining cars and a buffet-smoker. The high temperature and humidity have not sapped the energy of the card players; one car accommodates a bridge party, another a five-hundred party. A group who know not the allurements of the spotted pasteboards holds forth in "progressive conversation" in the observation parlor.

Representation of Societies

The representation by societies is as follows: American Society of Mechanical Engineers, 25; American Society of Civil Engineers, 23; American Institute of Electrical Engineers, 19; American Institute of Mining Engineering, 15; foreign delegates, 7. The remaining members of the party are guests and ladies.

R. B. T. Tinsley, manager of the Venezuela plant of the Barber Asphalt Paving Company, arrived in the United States from Venezuela just in time to take the special train from New York to the International Engineering Congress. Before going to Venezuela he was superintendent of construction of the Miraflores lock and dam.

Charles Warren Hunt, secretary of the American Society of Civil Engineers, was evidently intent on forgetting his responsibilities during the trip, probably expecting a full quota of work during the meeting of the society and the subsequent sessions of the International Congress. He wore in his coat lapel the badge of the Italian Society of Engineers, of which he is a member, but nowhere was the badge of the American Society of Civil Engineers in evidence on his person. Pressed for an explanation he said that the wearing of the Italian button made him a distinguished visiting engineer and so relieved him of responsibility.

Among the prominent men on the train were the following: H. J. E. Wenckelbach, of The Hague, and Robert Snellen, of Amsterdam, representing the Holland Engineering Society; Jean de Pulligny, of Paris, representing the French Government; José R. Villalon, commissioner of the Department of Public Works and a member of President Menocal's cabinet, Havana, representing the Cuban Government; Prof. A. E. Rohn, of Zurich, and Dr. Franz Nissler, of Freiburg, representing Switzerland; Roger Tappan, of Sjundea Station, Sjunby, Finland; Walter Chamley, of Sao Paulo, Brazil; John A. Brashear, president, American Society of Mechanical Engineers; J. J. Carty, president, American Institute of Electrical Engineers; W. L. Saunders, president, American Institute of Mining Engineers; Mansfield Merriman, president, American Society for Testing Materials, and Lawrence Addicks, president American Electrochemical Society.

Capacity of San Pedro Oil Reservoir Will Be 500,000 Barrels

The oil storage reservoir of the General Petroleum Company near San Pedro, Cal., on which construction has been started, as was noted in this journal Aug. 21, will have a capacity of 500,000 bbls., instead of 500,000,000 bbls., as was stated.